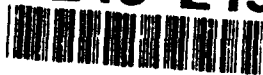


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REMEDIAL INVESTIGATION
REPORT

FOR

USATHAMA - RATSS
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI

VOLUME II

DAAA15-85-D 0015

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Work Order No. 2281-09-07

Prepared By

Roy F. Weston, Inc.
West Chester, Pennsylvania

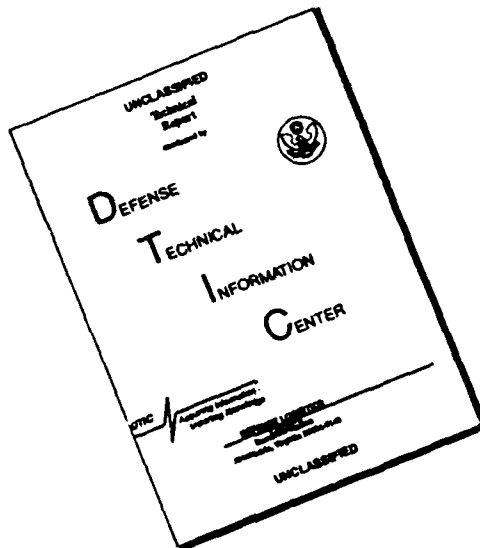
June 1990

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VOLUME II

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- B Monitoring Wells and Staff Gauging Elevations
- C Geologic Drill Logs
- D Geotechnical Data
- E Equations Used for Analysis of Pumping Test Data
- F Statistical Background Values
- G Chemical Data
- H Toxicity Summaries
- I List of Common and Scientific Names of Wildlife Species at LCAAP

Statement A per telecon
Denise Hancsak USATHAMA/CETHA-IR-A
Aberdeen Proving Ground, MD 21010-5401

NWW 11/8/91

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APPENDIX A

WELL DEVELOPMENT INFORMATION

WELL DEVELOPMENT INFORMATION

Well #	Total Depth	WLBD	WLAD	D&D	TWR	DDW	Method
14-3	25'	11'	16'	2/22-1 hr	65 gal	cloudy	bailed
2-8	29'	8'	29'	2/22-1 hr	118 gal	cloudy	bailed
5-7	36'	12'	24'	2/22-2.5 hr	135 gal	cloudy	bailed
12-5	34'	25'	26'	2/23-1hr	55 gal	cloudy	bailed
7-13	32'	24'	24.5'	2/23-1hr	45 gal	cloudy	bailed
8-7	39'	27'	39'	2/23-1.5 hr	67 gal	cloudy	bailed
8-8	43'	28'	33'	2/23-2 hr	84 gal	cloudy	bailed
16-6	31'	13'	13'	2/19-5hr	100 gal	cloudy	pumped
16-7	90'	13'	13'	2/2-45 min	425 gal	clear	pumped
17-8	85'	13'	11'	2/20-35 min	376 gal	clear	pumped
17-7	17'	6'	9'	2/20-2 hr	65 gal	cloudy	bailed
16-8	22'	10'	16.5'	2/21-1.5 hr	80 gal	cloudy	bailed
17-10	31'	9'	11'	2/21-2.5 hr	125 gal	cloudy	bailed
17-9	19'	9'	10.5	2/21-1.5 hr	55 gal	cloudy	bailed
14-1	28'	19'	26'	2/22-1.5 hr	65 gal	cloudy	bailed
16-11	23'	11'	16'	2/22-1 hr	65 gal	cloudy	bailed
7-11	28'	18'	20'	2/22-1 hr	60 gal	cloudy	bailed
8-6	35'	25'	25'	2/23-1 hr	55 gal	cloudy	bailed
16-13	23'	7'	12'	2/24-2 hr	55 gal	clear	pumped
16-12	31'	14'	26'	2/24-5 hr	90 gal	cloudy	pumped
18-7	85.5'	12.8'	--	2/21-2 hr	500 gal	clear	pumped
16-9	50.5'	24.2'	--	2/21-2 hr	160 gal	clear	pumped
14-4	81'	15.2'	--	2/21-2 hr	400 gal	clear	pumped

WELL DEVELOPMENT INFORMATION (Continued)

<u>Well #</u>	<u>Total Depth</u>	<u>WLBD</u>	<u>WLAD</u>	<u>D&D</u>	<u>TWR</u>	<u>DDW</u>	<u>Method</u>
12-6	88'	22.5'	--	2/21-1 hr	360 gal	clear	pumped
14-2	26'	13.3'	--	2/22-1.5 hr	85 gal	cloudy	pumped
3-8	85'	22.3'	--	2/22-1.5 hr	350 gal	clear	pumped
7-12	85'	20'	--	2/22-1 hr	360 gal	clear	pumped
16-10	62'	16'	--	2/22-1.5 hr	400 gal	clear	pumped

WLBD - Water level before development
 WLAD - Water level after development
 D & D - Date and duration of development
 TWR - Total water removed
 DDW - Description of development water

APPENDIX B
MONITORING WELLS AND STAFF GAUGING ELEVATIONS

TABLE B-1
Summary of Ditch Water Elevations
All Values Recorded at MSL

1 June 1988

<u>Staff Gauge</u>	<u>Gauge Elevation</u>	<u>Surface Water Elevation</u>
1	758.89	755.6
2	768.72	764.85
3	732.99	740.14
4	738.67	735.12
5	738.87	--
6	734.65	--
7	732.65	729.15
8	737.05	733.4
9	740.24	--
10	742.22	740.28
11	742.13	--

Locations of Staff Guages are shown in Figure 3-3

TABLE B-2
Summary of Groundwater Elevations
All Values Recorded at Feet Above MSL
1 June 1988

Monitoring Well	Ground Elevation	Top of PVC Elevation	Top of Screen Elevation	Bottom of Screen Elevation	Groundwater Elevation
1-1	774.9	776.78	760	755	772.28
1-2	763.53	765.15	756	746	760.61
1-3	762	763.16	728	718	759.16
1-4	772.72	775.35	764	747	762.72
1-5	784.2	786.47	778	764	778.81
1-6	762.6	764.69	739	726	758.51
1-7	796.08	797.83	773	743	781.31
1-7A	--	--	769	739	--
1-8	763.2	764.95	744	729	758.67
1-9	761.7	764.2	748	733	756.44
1-10	765.2	765.99	745	730	759.34
2-1	756	757.35	730	720	752.4
2-2	764	766.54	724	714	753.03
2-3	762.3	762.5	735	730	757.12
2-4	762.1	764.45	730	725	757.67
2-5	759.4	761.95	744	729	742.76
2-6	--	--	748	733	--
2-7	756.2	758.23	744	729	749.34
2-8	763.6	766.19	744	734	--
3-1	742.6	743.69	697	692	723.55
3-2	743.0	744.57	723	708	723.77
3-3	742.3	743.92	722	717	725.58
3-4	742.9	744.49	700	695	723
3-5	745.5	746.07	725	710	723.47
3-6	744.7	746.64	722	712	723.69
3-7	741.7	743.86	724	714	724.22
3-8	742.7	744.8	670	660	723.77
4-1	762.92	764.01	741	726	740.04
4-2	757.17	758.38	731	717	745.80
4-3	759.66	760.8	724	719	732.12
4-4	763.24	764.34	736	731	746.30
4-5	764.2	765.78	743	738	757.41
4-6	777.74	777.74	743	728	770.42
5-1	752.25	753.79	722	717	736.63
5-2	754.22	755.49	730	725	738.81
5-3	755.36	756.5	718	713	735.59
5-4	754.17	755.44	722	717	742.24
5-5	751.2	753.34	734	724	741.47
5-6	759.2	761.66	742	732	745.54
5-7	773.1	775.75	747	737	763.05
6-1	775.33	777.31	755	750	766.93
6-2	788.37	790.16	764	759	769.25
6-3	788.08	789.32	769	764	785.60
6-4	781.05	782.59	768	758	776.49
6-5	779	781.48	748	733	763.73
6-6	779.22	780.87	756	741	765.77
6-7	799.47	800.75	790	775	791.09
7-1	747.8	748.91	723	708	725.47
7-2	747.5	748.82	729	709	729.22
7-3	744.1	745.68	719	704	739.60
7-4	742.1	743.84	717	712	725.52
7-5	748.1	749.35	728	708	725.69

TABLE B-2 (Cont.)
Summary of Groundwater Elevations
All Values Recorded at Feet Above MSL
1 June 1988

Monitoring Well	Ground Elevation	Top of PVC Elevation	Top of Screen Elevation	Bottom of Screen Elevation	Groundwater Elevation
7-6	745.5	746.84	712	717	725.51
7-7	741.8	743.82	724	714	725.29
7-8	742.8	745.12	726	716	725.01
7-9	745.8	748.08	728	718	726.22
7-10	743.9	746.2	727	717	725.41
7-11	741.56	743.55	726	716	724.97
7-12	741.6	744.03	669	659	722.60
7-13	746.8	749.45	725	715	725.46
MW-1	821.37	822.58	--	--	789.77
MW-2	811.17	812.21	--	--	789.44
MW-3	780.05	781.2	--	--	768.53
MW-4	766.28	767.51	--	--	759.84
MW-5	820.76	804.84	--	--	794.09
8-1	751.26	750.51	726	711	732.04
8-2	753.42	755.96	743	713	733.48
8-3	752.56	751.83	730	715	743.48
8-4	762.06	764.28	750	742	748.88
8-5	783.86	785.81	772	756	770.27
8-6	751.84	754.57	730	720	729.58
8-7	750.7	753.14	722	712	725.87
8-8	751.67	754.02	718	708	725.71
9-1	740.16	741.29	728	701	728.22
9-2	740.56	741.62	706	701	726.07
9-3	739.46	740.86	706	701	728.66
9-4	743.16	744.67	729	701	729.67
10-1	855.72	856.9	842	837	838.77
10-2	854.41	854.99	826	821	830.72
10-3	836.43	837.61	817	812	828.26
10-4	842.78	843.88	813	808	818.48
10-5	830.28	832.13	820	815	817.73
10-6	854.73	856.49	821	806	832.53
11-1	790	791.3	771	766	785.06
11-2	790.89	792.12	772	767	782.71
11-3	806.82	808.72	783	778	790.45
11-4	794.15	795.15	775	770	786.40
12-1	--	--	--	--	--
12-2	742.3	744.49	725	715	724.17
12-3	742.5	744.45	726	716	723.05
12-4	743.3	745.30	726	716	724.83
12-5	746.2	748.22	722	712	724.06
12-6	743.3	745.26	667	657	723.96
14-1	745	746.93	727	717	726.74
14-2	735.83	737.78	723	713	725.00
14-3	735.33	737.78	725	715	724.96
14-4	736.13	738.6	667	657	724.82
16-1	855.7	857.93	828	818	832.66
16-2	762.6	764.38	739	729	754.39
16-3	765	766.56	741	731	755.26
16-4	763	764.91	731	721	754.81
16-5	761.6	763.04	738	728	749.96
16-6	738.26	740.27	659	649	726.84
16-7	738.3	740.43	719	709	728.06
16-8	747.1	749.94	735	725	737.38
16-9	747.1	750.01	709	699	727.73
16-10	762.7	765.45	710	700	750.59
16-11	762.9	765.06	712	702	721.91

TABLE B-2 (Cont.)
Summary of Groundwater Elevations
All Values Recorded at Feet Above MSL
1 June 1988

<u>Monitoring Well</u>	<u>Ground Elevation</u>	<u>Top of PVC Elevation</u>	<u>Top of Screen Elevation</u>	<u>Bottom of Screen Elevation</u>	<u>Groundwater Elevation</u>
16-12	773.8	776.17	753	743	762.02
16-13	773.38	775.4	766	756	767.57
17-1	838.59	842.42	779	754	808.87
17-2	821.29	824.91	766	741	799.10
17-3	776.42	780.04	712	687	763.75
17-4	782.32	785.82	710	685	774.54
17-5	785.2	787.66	773	763	778.51
17-6	788.2	790.46	771	761	760.57
17-7	746.1	748.6	730	720	736.69
17-8	745.4	748.14	662	652	737.47
17-9	737.45	740.05	736	726	732.82
17-10	737.45	740.04	728	718	720.07
18-1	738.2	740.30	726	716	727.03
18-2	737.5	739.73	725	715	731.17
18-3	740.12	738.0	728	718	729.01
18-4	739.2	741.51	727	717	727.23
18-5	739.9	741.96	727	717	727.55
18-6	736.5	738.59	724	714	726.67
18-7	737.4	739.26	654	644	726.85

Note: Some of the screen depths have been estimated from boring logs.

APPENDIX C
GEOLOGIC DRILL LOGS

TABLE C-1
SUMMARY OF NEW (1988) WELL CONSTRUCTION DATA

WELL NUMBER	SURFACE ELEVATION	TOP OF RISER ELEVATION	TOTAL DEPTH	BOTTOM HOLE ELEVATION	BOTTOM SCREEN ELEVATION	TOP OF SCREEN ELEVATION	SCREEN LENGTH	TOP OF SAND PACK
2-8	763.6	766.19	59.0	704.6	734.6	744.6	10	748.6
3-8	742.7	744.8	82.0	660.7	660.7	670.7	10	675.2
5-7	773.1	775.75	50.0	723.1	737.1	747.1	10	751.4
7-11	741.56	743.55	26.0	715.56	715.56	725.56	10	727.56
7-12	741.6	741.6	83.0	658.6	659.1	669.1	10	673.6
7-13	746.8	749.45	32.0	714.8	714.8	724.8	10	728.3
8-6	751.84	754.57	32.0	719.84	719.84	729.84	10	733.44
8-7	750.7	753.14	40.0	710.7	711.7	721.7	10	727.2
8-8	751.67	754.02	45.0	706.67	708.67	718.67	10	724.07
12-5	746.2	748.22	34.0	712.2	712.2	722.2	10	728.2
12-6	743.3	745.26	86.5	656.8	656.8	666.8	10	671.7
14-1	745.0	746.93	34.5	710.5	717.0	727.0	10	734.2
14-2	735.83	737.78	23.5	712.33	712.83	722.83	10	725.83
14-3	735.33	737.38	20.5	714.83	715.33	725.33	10	727.33
14-4	736.13	738.60	78.5	657.63	657.63	667.63	10	673.13
16-6	738.26	740.27	30.0	708.26	709.26	719.26	10	720.26
16-7	738.3	740.43	94.0	644.3	649.3	659.3	10	664.3
16-8	747.1	749.94	24.0	723.01	725.1	735.1	10	738.1
16-9	747.1	750.01	50.0	697.1	699.1	709.1	10	714.1
16-10	762.7	765.45	64.0	698.7	700.2	710.2	10	715.2
16-11	762.9	765.06	63.0	699.9	701.9	711.9	10	715.9
16-12	773.8	776.17	32.0	741.8	742.8	752.8	10	755.8
16-13	773.38	775.4	20.0	753.38	753.38	763.38	10	767.38
17-7	737.45	740.05	17.5	719.95	720.45	730.45	10	731.45
17-8	737.45	740.05	86.0	651.45	651.95	661.95	10	666.45
17-9	746.1	748.6	20.5	725.6	726.1	736.1	10	738.1
17-10	745.4	748.14	28.0	717.4	717.9	727.9	10	760.4
18-7	737.4	739.26	94.0	643.4	643.9	653.9	10	658.4

NOTE: ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 1 of 3	HOLE NO. 2-8
START 2/2/88	FINISH 2/3/88	DRILLER Layne-Western	DRILL METHOD B-61/HSA	BOREHOLE DIAMETER 12"	WELL DIAMETER 4" PVC	TOTAL DEPTH 59.00'			
LOGGER R. Bennett		TOP OF CASING ELEV. 766.19	GROUND ELEVATION 763.60	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED 26.50'/737.10' Drilling					

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	5	3 0 8					CL		SILTY CLAY : trace of silt and lignite fragments, low plasticity, moist, trace red mottling, medium brown	
2	SS	14	4 5 8	760	5			CL		abundant mottling	
3	SS	18	4 5 6					ML		CLAYEY SILT : well sorted, abundant clay, trace of lignite fragments, moist, abundant mottling, red-brown	
4	SS	18	3 4 6	755	10			ML		same as above	
5	SS	18	3 6 4					ML		some clay, trace carbonised small nodules	
6	SS	18	3 4 5	750	15			CL		SILTY CLAY: well sorted, some silt, trace lignite fragments moderately plastic, moist to wet, red-brown	
7	SS	18	4 5 5					CL		same as above	
8	SS	18	4 4 5	745				CL		abundant silt	

FASTN 01588
 SS = SPLIT SPOON
 C = CORE
 CS = CONTINUOUS SAMPLER
 D = DENNISON
 CT = CUTTING
 OT = OTHER

LCAAP
Independence, Mo.

PAGE NO.
1 of 3

HOLE NO.
2-8



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 2 of 3	HOLE NO. 2-8	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWB*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	6 6 6	740	25			CL	as above, medium gray	
10	SS	14	8 7 10	735	30			ML	CLAYEY SILT: well sorted, trace clay, saturated, medium gray, no mottling	
11	SS	16	5 5 7	730	35			ML	same as above	
12	SS	18	5 5 6	725	40			ML	same as above	

*ASTM D1585
 SS = SPLIT SPOON
 D = DEBRIS

ST = SHELVE TUBE
 C = CORE
 CT = CUTTINGS

CS = CONTINUOUS SAMPLER
 OT = OTHER

LCAAP
Independence, Mo.

PAGE NO.
2 of 3

HOLE NO.
2-8



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 3 of 3		HOLE NO. 2-8	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES	
13	SS	18	6	720	45			ML	same as above		
14	SS	18	10 12 14	715	50			CL	SILTY CLAY: well sorted, trace silt, low plasticity, moist, trace mottling, dark gray		
15	SS	4	40 50 50/1"	710	55			Sh	SHALE: well sorted, trace silt, friable, moist, dark gray		
16	SS	3	80/5"	705				Sh	light gray		
									End of boring @ 59.0 feet		

FASTW 01555

SS = SPLIT SPOON

CT = CUTTING

SY = SHELBY TUBE

C = CORE

OT = OTHER

CS = CONTINUOUS SAMPLER

LCAAP
Independence, Mo.

PAGE NO.
3 of 3

HOLE NO.
2-8



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.	
				LCAAP, Independence, Mo.				1 of 4	3-8	
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH				
2/19/88	2/20/88	Layne-Western	Mud Rotary	7 7/8"	4" PVC	82.50'				
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED						
R. Bennett		744.80	742.70	21.03'/721.67' 6/1/88						
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	8	3 4 6	740				CL	SILTY CLAY: well sorted, trace silt, roots and lignite, low plasticity, moist, trace mottling, medium gray	
2	SS	10	3 3 5		5			CL	medium brown	
3	SS	18	5 6 9	735				SM	SAND: medium, well sorted, some silt, saturated, trace mottling, medium brown, moist, with some thin lenses of silt, trace clay	
4	SS	18	7 11 16		10			SM	finer	
5	SS	8	5 4 6	730				SM	same as above	
6	SS	0	3 1 1		15			SM		NO RECOVERY
7	SS		2 2 2					SM	red-brown, saturated	
8	SS		6 5 7	725				SM	no silt lenses	

*ARTN DYSSES ST = SHELBY TUBE
 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 D = DEBRIS CT = CUTTINGS OT = OTHER

LCAAP
 Independence, Mo.

PAGE NO. HOLE NO.
 1 of 4 3-8



GEOLOGIC DRILL LOG					PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 4	HOLE NO. 3-8	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	DESCRIPTION	NOTES
9	SS	8	9 5	720			SM	trace silt, medium gray	
10	SS	14	2 4 13	715			SM	some lignite fragments	
11	SS	18	14 20 26	710			SM	interbedded thin lenses of abundant lignite fragments	
12	SS	10	45 20 30	705			SM	well sorted	

ST = SPLIT TUBE
SS = SPLIT SPOON
CT = CUTTING

ST = SPLIT TUBE
C = CORE
CT = CUTTING

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

PAGE NO.
2 of 4

HOLE NO.
3-8



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		3 of 4	3-8				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
13	SS	14	10 10 14	700				SM		very abundant lignite fragments, sand size with fine sand, saturated	
14	SS	18	23 30 41	695				SM		SAND, fine to medium with trace lignite and fine gravel	
15	SS	6	32 36 39	690				SM		trace coarse sand, no lignite	
16	SS	13	20 25 19	685				SM		abundant lignite alluvium, sand is medium gray	
17	SS	16	17	680				SM		poorly sorted, trace silt, medium gravel and thin lignite lenses, medium to dark gray	

WASH BY 50% ST = SHELBY TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

R = REMOVED CT = CUTTINGS OT = OTHER

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Independence, Mo.

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.		4 of 4	3-8		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	DESCRIPTION	NOTES
			20	65				see above	
18	SS	16	19 18 19	675			SM	no lignite lenses	
19	SS	10	20 16 18	670			SM	medium to coarse	
20	SS	10	14 16 16	665			SM	fine to coarse, abundant fine to coarse gravel	
				80					
LIMESTONE BEDROCK End of boring @ 82.0 feet									

VASTH D1536
 SS = SPLIT SPOON
 D = DENNISON

ST = SHELBY TUBE
 C = CORE
 CT = CUTTINGS

CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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HOLE NO.
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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 3	5-7		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/5/88	2/5/88	Layne-Western	B-61/HSA	12"	4" PVC	50.00'					
LOGGERS		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		775.75	773.10	12.70'/760.40' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLDG	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	4	6 5 5	770				CL		SILTY CLAY: well sorted, trace silt, low plasticity, moist, trace mottling, red-brown	
2	SS	14	7 12 16		5			CL		trace roots, abundant mottling	
3	SS	18	5 5 5					CL		same as above	
4	SS	18	4 4 5	765				CL		trace lignite	
5	SS	18	10 12 14		10			CL		abundant silt and lignite, moist brown, some vertical solution channels	
6	SS	18	10 9 8	760				CL		same as above	
7	SS	18	10 12 12		15			CL		trace lignite	
8	SS	18	7 10 9	755				CL		same as above	

ASTM D1556 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 D = DISCHARGE CT = CUTTING OT = OTHER

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Independence, Mo.

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1 of 3 5-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.			
				LCAAP, Independence, Mo.		2 of 3	5-7			
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	5 7 8	750	25			CL	no lignite, trace silt	
									saturated at 26.0 feet during drilling	
10	SS	18	9 11 13	745	30			CL	trace coarse sand, fine gravel, lignite alluvium	
11	SS	18	12 12 14	740	35			CL	abundant silt	
12	SS	18	18 18 16	735	40			CL	same as above	

ASTM D1586 ST = SPLIT TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

D = DEBRIS CT = CUTTINGS OT = OTHER

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Independence, Mo.

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GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 3 of 3	HOLE NO. 5-7
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
13	SS	8	13 23 50/5"	730				ML		CLAYEY SILT: well sorted, abundant clay, moist, abundant mottling, red-brown, thin clay lenses			
					45								
										SHALE BEDROCK: well sorted, friable, moist, light gray			
14	SS	6	50 50/5"	725				Sh					
					50					End of boring @ 50.0 feet			

WESTON SYSTEMS
 SS = SPLIT SPOON
 C = CORE
 CT = CUTTINGS
 SY = SHELBY TUBE
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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HOLE NO.
 5-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	WELL NO.
				LCAAP, Independence, Mo.				1 of 2	7-11
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH			
2/7/88	2/7/88	Layne-Western	B-61/HSA	12"	4" PVC	26.00'			
LOGGER		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED					
R. Bennett		743.55	741.56	18.58'/722.98' 6/1/88					

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANK	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	12	3 5 7	740				OL		TOPSOIL: clayey humus, well sorted, low plasticity, moist, black	
2	SS	12	5 6 7		5			CL		SILTY CLAY: some silt, abundant roots, low plasticity, moist, abundant mottling, black	
3	SS	18	4 6 7	735				CL		abundant silt and lignite alluvium, some clay nodule formation, vertical solution channels, red-brown	
4	SS	18	3 5 8		10			ML		CLAYEY SILT: abundant clay, trace fine sand, some black clay nodules, abundant mottling, wet, red-brown	
5	SS	18	1 2 2	730				ML		interlayered clay lenses, medium gray	
6	SS	18	1 2 2		15			ML			
7	SS	16	3 6 8	725				SM		SAND: fine, well sorted, trace silt, saturated, abundant mottling, medium brown	
8	SS	18	1 2 2					SM		some interlayered silt lenses	

*ASTM D1556 SS = SPLIT SPOON D = DENNISON				ST = SHELBY TUBE C = CORE CT = CUTTINGS				CS = CONTINUOUS SAMPLER OT = OTHER				LCAAP Independence, Mo.		PAGE NO.	WELL NO.
												1 of 2	7-11		



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 2 of 2	HOLE NO. 7-11	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	2 800	720	25	[Graphic Log: Stippled pattern for sand, horizontal lines for silt]	[Well Construction: Vertical lines for casing]	SM	SAND: fine, well sorted, trace of medium sand and silt, no mottling, saturated, medium brown	
									End of boring @ 26.0 feet	

WASH DYSOS
SS = SPLIT SPOON
D = DENNISON

SY = SHELBY TUBE
C = CORE
CT = CUTTINGS

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7-11



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 4	7-12		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/9/88	2/10/88	Layne-Western	Gardner Davr 500	8"	4" PVC	83.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		744.03	741.60	21.43'/720.17' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
				740							
					5						
				735							
					10						
				730							
					15						
				725							
FOR INFORMATION FROM 0 - 25 FEET, SEE GEOLOGIC LOG 7-11											

PASTIN 01586

SS = SPLIT SPOON

D = DENNISON

ST = SHELBY TUBE

C = CORE

CT = CUTTINGS

CS = CONTINUOUS SAMPLER

OT = OTHER

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HOLE NO.
7-12



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 4	HOLE NO. 7-12
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
				720						FOR INFORMATION FROM 0 - 25 FEET, SEE GEOLOGIC LOG 7-11			
1	SS	7	3 8 10		25			SM		SAND: fine to medium, well sorted, saturated, medium brown with lenses of dark brown			
2	SS	0	8 8 11		35			SM			No Recovery		
3	SS	13	30 44 42		40			SM		SAND: same as above			
				700									

ASTM D1586 ST = Shelby Tube

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

D = DEWILSON CT = CUTTINGS OT = OTHER

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HOLE NO. 7-12



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 3 of 4	HOLE NO. 7-12		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
4	SS	5	17 17 1	45			SM	SAND: same as above	
5	SS	8	23 27 30	50			SM	fine, well sorted, trace of silt, saturated, medium brown	
6	SS	6	8 9 11	55			SM	SAND: medium to coarse, well sorted, saturated, medium brown	
7	SS	10	17 21 25	60			SM	SAND: fine to coarse, poorly sorted, trace of fine gravel, saturated, gray-brown, interbedded with lignite alluvium	
8	SS	9	20				SM	SAND: same as above, small lenses of abundant silt and clay above lignite layers	

WASH DYSMS
SS = SPLIT SPOON
D = DENISON

ST = SHELBY TUBE
C = CORE
CT = CUTTING

CS = CONTINUOUS SAMPLER
OT = OTHER

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7-12



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		4 of 4	7-12				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	9	18 32 43		65			SM		see above	
					675						
					70					SAND: medium, well sorted, trace of large gravel, saturated, medium gray, interbedded with lignite alluvium	
					670						
10	SS	6	20 19 21		75			SM		coarse, abundant medium to coarse gravel, trace of limestone fragments, saturated, medium gray	
					665						
11	SS	6			80			SM		SAND: same as above, increase in limestone fragments	
					660						
										LIMESTONE: bedrock at 83.0'	
										End of boring @ 83.0 feet	

WASH BYSS ST = SHELBY TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

D = DENLISON CT = CUTTINGS OT = OTHER

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Independence, Mo.

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GEOLOGIC DRILL LOG			PROJECT NAME AND LOCATION			PAGE NO.	HOLE NO.
			LCAAP, Independence, Mo.			1 of 2	7-13
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH	
2/8/88	2/8/88	Layne-Western	B-61/HSA	12"	4" PVC	32.00'	
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED			
R. Bennett		749.45	746.80	23.99'/722.81' 6/1/88			

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOUSE	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	5	3 4 6	745				OL		TOPSOIL: clayey humus, trace silt, roots, moist, trace mottling, black	
2	SS	12	6 8 12		5			ML		CLAYEY SILT: well sorted, some clay, moist, trace mottling, friable, dark gray	
3	SS	14	5 11 13	740				CL		SILTY CLAY: well sorted, trace roots and humus, very low plasticity, moist, abundant mottling, black	
4	SS	16	7 8 11		10			CL		trace mottling	
5	SS	18	4 7 8	735				CL		trace silt	
6	SS	18	4 5 6		15			ML		CLAYEY SILT: well sorted, abundant clay, trace roots and carbonised nodules, some vertical solution channels, moist, trace mottling, dark gray	
7	SS	18	3 4 6	730				ML		interbedded with silty clay	
8	SS	18	4 4 4					ML		same as above	

GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	ROLE NO.			
				LCAAP, Independence, Mo.		2 of 2	7-13			
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	INTERNAL	DESCRIPTION	NOTES
9	SS	18	5 14 18	725			SM		SAND: medium, well sorted, trace fine sand and silt, saturated, medium brown	
10	SS	18	3 7 12	720			SM		fine grained	
				30						
				715					End of boring @ 32.0 feet	

ASTM D1585
SS = SPLIT SPOON
C = CORE
CT = CUTTINGS
ST = SHELBY TUBE
C = CORE
CT = CUTTINGS
CS = CONTINUOUS SAMPLER
OT = OTHER

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ROLE NO.
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GEOLOGIC DRILL LOG			PROJECT NAME AND LOCATION			PAGE NO.	HOLE NO.
			LCAAP, Independence, Mo.			1 of 2	8-6
START	FINISH	DRILLER	DRILL METHOD	SCREEN/PIPE DIAMETER	WELL DIAMETER	TOTAL DEPTH	
2/8/88	2/9/88	Layne-Western	B-61/HSA	12"	4" PVC	32.00'	
LOGGERS		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED			
R. Bennett		754.57	751.84	24.99'/726.85' 6/1/88			

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	8	7 10 16	750				FILL		FILL: mixed clay and silt	
2	SS	14	8 8 10		5			CL		CLAY: well sorted, abundant humus, trace roots, low plasticity, moist, trace mottling, black	
3	SS	18	4 7 9	745				CL		trace large gravel, medium brown	
4	SS	18	6 7 9		10			CL		SILTY CLAY: abundant silt, trace coarse sand, fine gravel, lignite alluvium, low plasticity, abundant red and yellow mottling, red-brown	
5	SS	18	4 6 8	740				CL		trace vertical solution channels	
6	SS	18	2 4 3		15			CL		moderate plasticity	
7	SS	18	2 3 3	735				CL		medium brown	
8	SS	18	3 3 3					CL		trace silt	

SCREEN DIAMETER SS = SPLIT SPOON C = CORE CT = CUTTINGS OTHER = OTHER			SY = SHELLEY TUBE C = CORE CS = CONTINUOUS SAMPLER OTHER = OTHER			LCAAP Independence, Mo.		PAGE NO.	HOLE NO.
								1 of 2	8-6



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 2	HOLE NO. 8-6
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE	INTERVAL	DESCRIPTION	NOTES		
9	SS	18	2 4 3		730			CL		SILTY CLAY: well sorted, trace silt and lignite alluvium, trace red and yellow mottling, wet, medium brown, vertical solution channels			
				25									
				725									
10	SS	18	4 4 6		30			CL		no lignite			
				720									
End of boring @ 32.0 feet													

WESTON SYSTEMS
 SS = SPLIT SPOON
 C = CORE
 CT = CUTTING
 ST = SHELBY TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	WELL NO.		
				LCAAP, Independence, Mo.				1 of 2	8-7		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/10/88	2/15/88	Layne-Western	B-61/HSA 10"ID	14"	4" PVC	40.00'					
LOGGERS		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		753.14	750.70	27.27'/723.43' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS	ELEV.	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	6	4 7 8	750						FILL: mixed clay, silt, shale fragments, moist	
2	SS	10	2 4 7							same as above	
3	SS	6	13 10 12	745	5					same as above	
4	SS	14	8 10 8							same as above	
5	SS	8	2 3 4	740	10			CL		CLAY: abundant humus, trace roots, moist, trace mottling, black, old soil horizon	
6	SS	14	2 3 4					CL		trace humus, dark gray	
7	SS	18	2 2 4	735	15			CL		abundant carbonized nodules oxidized red and yellow	
8	SS	18	2 3 4					CL		same as above	

PASTIN DYSSES
 SS = SPLIT SPOON
 S = SPLIT SPOON

ST = SPLIT TUBE
 C = CORE
 CT = CUTTING

CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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WELL NO.
 8-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 2 of 2	HOLE NO. 8-7	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	2 3 3	730	25			CL	SILTY CLAY: trace silt, low plasticity, moist to wet, trace mottling, dark gray	
10	SS	18	2 2 3	725	30			CL	abundant silt, trace fine sand, saturated	
11	SS	18	2 2 2	720	35			ML	CLAYEY SILT: trace clay and fine sand, saturated, dark gray	
12	SS	14	1 2 3	715	40			ML	some thin lenses of fine sand	
									End of boring @ 40.0 feet	

WESTON SYSTEMS BY = BENTONITE
 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 R = RECOVERED CT = CUTTING OF A CORE

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 Independence, Mo.

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HOLE NO.
8-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 3	8-8		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/16/88	2/17/88	Layne-Western	B-61/HSA 10"ID	14"	4" PVC	45.00'					
LOGGERS		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		754.02	751.67	28.31'/723.36' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	18	12 21 7	750				FILL		FILL: clayey silt, trace sand, very stiff, moist, medium brown	
2	SS	18	18 18 22		5					trace shale fragments, small gravel, roots and mottling	
3	SS	18	12 13 17	745						gray to brown-green	
4	SS	18	3 4 4		10			CL		SILTY CLAY: abundant silt, trace fine sand and roots, moist, dark brown	
5	SS	18	3 3 4	740				CL		trace fine gravel, dark brown to black	
6	SS	18	1 2 1		15			CL		high plasticity, black	
7	SS	18	4 6 7	735				CL		moderate plasticity, trace oxidation on fine gravel	
8	SS	18	4 6 8					CL		medium gray	

*ASTM D1586 ST = SHELBY TUBE
 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 D = DREDGE CT = CUTTINGS QT = OTHER

LCAAP
 Independence, Mo.

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GEOLOGIC DRILL LOG						PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 3	HOLE NO. 8-8		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	INTERVAL	DESCRIPTION	NOTES
9	SS	18	4 8 8	730	25			CL		abundant silt	
10	SS	18	2 3 3	725	30			CL		trace fine sand	
11	SS	18	2 1 2	720	35			ML		CLAYEY SILT: well sorted, abundant clay, trace fine sand, high plasticity, wet, olive green-gray	
12	SS	18	2 4 4	715	40			ML		same as above	
				710							

SYNTH DYSSES
SS = SPLIT SPOON
O = REMILSON

SY = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

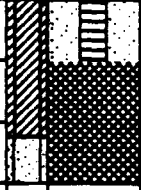
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HOLE NO.
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GEOLOGIC DRILL LOG	PROJECT NAME AND LOCATION LCAAP, Independence, Mo.	PAGE NO. 3 of 3	HOLE NO. 8-8
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SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
13	SS	18	1 3 2					SM		wet, medium gray SAND: fine to medium, well sorted, trace silt, wet, medium gray End of boring @ 45.0 feet	

*ASTM D1586 SS = SPLIT SPOON D = DENISON	ST = SHELBY TUBE C = CORE CT = CUTTINGS	CS = CONTINUOUS SAMPLER OT = OTHER	LCAAP Independence, Mo.	PAGE NO. 3 of 3	HOLE NO. 8-8
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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 1 of 2	HOLE NO. 12-5	
START 2/1/88	FINISH 2/2/88	DRILLER Layne-Western	DRILL METHOD B-61 HSA	BOREHOLE DIAMETER 12"	WELL DIAMETER 4" PVC	TOTAL DEPTH 34.00'				
LOGGER R. Bennett		TOP OF CASING ELEV. 748.22	GROUND ELEVATION 746.20	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED 24.16'/722.04' 6/1/88						
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOKS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	12	6 12 14	745				FILL	FILL: silty clay, trace silt, roots and lignite alluvium, low plasticity, moist, abundant mottling, interlayered gray, red-brown, dark brown	
2	SS	16	10 13 14		5				medium brown	
3	SS	18	5 5 7	740					trace vertical solution channels	
4	SS	16	3 3 6		10			SM	SAND: fine, well sorted, abundant silt, abundant mottling, moist, trace vertical solution channels, medium gray	
5	SS	18	3 3 6	735				SM	some silt, no solution channels, moist to wet	
6	SS	18	4 4 1		15			SM	medium, medium brown	
7	SS	14	3 2 1	730				ML	SANDY SILT: abundant fine sand, moderately sorted, moist to wet, medium brown	
8	SS	18	4 3 1					ML	SILTY SAND: fine, moderately sorted, abundant silt, moist to wet, medium brown	

*ASTM D1586 SY = SHELBY TUBE
 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 D = DENNISON CT = CUTTINGS OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
12-5



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				2 of 2	12-5		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	ELEV.	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	3 4 3	725				SM		fine, moderately sorted, abundant silt, wet, medium brown	
10	SS	18	4 3 2	720	25			SM		trace silt	
11	SS	18	3 3 3	715	30			SM			
										End of boring @ 34.0 feet	

WESTON SYSTEMS

SS = SPLIT SPOON

BT = BENTONITE

ST = SPLIT TUBE

C = CORE

CS = CONTINUOUS SAMPLER

CT = CUTTING

OT = OTHER

LCAAP

Independence, Mo.

PAGE NO.

2 of 2

HOLE NO.

12-5



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 1 of 5	HOLE NO. 12-6	
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH				
2/15/88	2/16/88	Layne-Western	HSA/Tri-cone	8"	4" PVC	86.50'				
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED						
R. Bennett		745.26	743.30	21.30'/722.00' 6/1/88						
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	8	4 4 6					OL	TOPSOIL: clayey humus, fine, abundant roots, moist, black	
2	SS	12	4 5 6	740	5			CL	CLAY: trace silt, lignite alluvium and roots, moist, abundant mottling, red-brown	
3	SS	16	3 5 6					CL	interlayered with sand	
4	SS	16	6 7 9	735	10			SM	SAND: fine to medium, moderately sorted, trace silt and lignite fragments, some thin clay lenses, saturated, abundant mottling, red-brown	
5	SS	18	1 1 1					ML	SILT: moderately sorted, trace lignite fragments, some thin clay lenses, saturated, abundant mottling, red-brown	
6	SS	18	2 2 1	730	15			ML	same as above	
7	SS	18	6 7 8					SM	SAND: fine to medium, well sorted, trace silt, saturated, brown	
8	SS	14	12 15 15	725				SM	same as above	

*ASTM D1586
 SS = SPLIT SPOON
 D = REMNISON

SY = SHELBY TUBE
 C = CORE
 CT = CUTTINGS

CS = CONTINUOUS SAMPLER
 = OTHER

LCAAP
Independence, Mo.

PAGE NO. 1 of 5 HOLE NO. 12-6



GEOLOGIC DRILL LOG	PROJECT NAME AND LOCATION LCAAP, Independence, Mo.	PAGE NO.	HOLE NO.
		2 of 5	12-6

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	16	14 19 25	720			SM		same as above	
10	SS	8	4 5 5	715			SM		fine, moderately sorted, trace medium sand and silt, trace lignite alluvium, dark brown,	
11	SS	14	18 28 31	710			SM		medium brown, no lignite	
12	SS	8	14 13 15	705			SM		same as above	

ASTM D1586 SY = SHELBY YOUNG
 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 D = DENNISON CT = CUTTINGS OT = OTHER

LCAAP
 Independence, Mo.

PAGE NO. HOLE NO.
 2 of 5 12-6



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		3 of 5	12-6				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
13	SS	14	16 16 19	700				SM		trace silt and coarse sand	
14	SS	8	40 50/4"	695				SM		fine, trace silt and medium sand	
15	SS	14	27 25 29	690				SM		medium, trace silt and coarse sand	
16	SS	16	30 28 33	685				SM		fine grained, well sorted, trace silt	
17	SS	14	19	680				SM			

ASTM D1585
SS = SPLIT SPOON
D = DENLISON

ST = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
12-6



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.			
				LCAAP, Independence, Mo.		4 of 5	12-6			
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
			22		65				coarse, poorly sorted, trace silt, fine sand and fine gravel, trace light brown shale	
18	SS	10	18 25 33	675	70			SM	same as above	
19	SS	8	12 15 16	670	75			SM	same as above	
20	SS	12	21 31 36	665	80			SM	fine to coarse	
21	SS	10	12 25 16	660	85			SM	SAND: fine to coarse, poorly sorted, trace fine gravel, saturated, medium brown	

ASTM D1585 ST = SHELBY TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

D = DENLISON CT = CUTTINGS OT = OTHER

LCAAP
Independence, Mo.

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GEOLOGIC DRILL LOG		PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.			
		LCAAP, Independence, Mo.				5 of 5	12-6			
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
									LIMESTONE End of boring @ 86.5 feet	

ASTM D1586
SS = SPLIT SPOON
D = DENNISON

ST = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

PAGE NO.
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HOLE NO.
12-6



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	WOLE NO.		
				LCAAP, Independence, Mo.				1 of 2	14-1		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
1/24/88	1/26/88	Layne-Western	HSA	10"	4" PVC	35.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		746.93	745.00	20.19'/724.81' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	4	6 5 5	745						FILL: silty clay, abundant silt, trace roots, low plasticity, moist, trace mottling, dark brown	
2	SS	18	4 4 6	740	5					mixture clay, silt, and fine sand, trace coarse gravel, medium brown	
3	SS	18	2 2 3					CL		SILTY CLAY: some silt and humus, moderate plasticity, wet, trace mottling, black, older soil horizon	
4	SS	18	2 3 2					CL		older soil horizon	
5	SS	18	3 6 5	735	10			CL		abundant silt, trace fine sand and lignite fragments, low plasticity, moist, some mottling, dark gray	
6	SS	18	5 6 7	730	15			CL		trace silt and lignite, abundant mottling, medium gray	
7	SS	18	2 4 4					CL		abundant lignite fragments	
8	SS	18	6 10 8					SM		SAND: fine to medium, moderately sorted, trace silt and lignite, saturated, medium brown	



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 2	HOLE NO. 14-1
SAMPLE NO.	SAMPLE TYPE	RECOVERY -	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
9	SS	18	4 6 6	720	25			SM		fine to medium, moderately sorted, silty clay at 25'	No sample taken here due to sand heave in augers		
	SS	12	6 8 15	715	30			SM		SAND: fine to coarse, poorly sorted, abundant silt and clay, saturated, medium gray			
										End of boring @ 34.5 feet			

WESTON 01528
 SS = SPLIT SPOON . C = CORE
 A = AUGER SOIL CT = CUTTINGS OT = OTHER
 SY = SHELBY TUBE CS = CONTINUOUS SAMPLER

LCAAP
 Independence, Mo.

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2 of 2
 HOLE NO.
14-1



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 2	14-2		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
1/27/88	1/28/88	Layne-Western	B-61/HSA	12"	4" PVC	23.50'					
LOGGERS		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		Unknown	735.83	12.78'/723.05' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANDS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	4	4 3 4	735				OL		TOPSOIL: clayey humus, well sorted, moist, black	
2	SS	14	4 7 10		5			CL		CLAY: trace humus and roots, low plasticity, moist, trace mottling, black	
3	SS	18	8 7 9	730				CL		trace silt and lignite fragments, trace oxidized nodules	
4	SS	18	4 4 5		10			CL		abundant mottling, light gray	
5	SS	18	3 3 3	725				CL		same as above	
6	SS	18	4 8 6		15			SM		SAND: well sorted, fine, trace silt, saturated, light brown, some layered lignite alluvium	
7	SS	18	4 3 4	720				SM		medium brown	
8	SS	18	2 9 7					SM		interbedded with silty clay lenses, saturated, medium gray	

SS = SPLIT SPOON
 OL = OLIVE
 CL = CLAY
 SM = SAND
 ST = SILENT TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 CT = CUTTING
 OT = OTHER

LCAAP
 Independence, Mo.

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HOLE NO.
 14-2



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.	
				LCAAP, Independence, Mo.				2 of 2	14-2	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	4 9 7	715			SM		SAND: with interbedded silty clay lenses as above	
End of boring @ 23.5 feet										

ASTM D1586
SS = SPLIT SPOON
D = REMOVED

ST = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
14-2



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.
				LCAAP, Independence, Mo.				1 of 2	14-3
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH			
1/29/88	2/1/88	Layne-Western	B-61/HSA	12"	4" PVC	20.50'			
LOGGER		TOP OF CASTING ELEV.		GROUND ELEVATION		DEPTH/ELEVATION GROUNDWATER - DATE MEASURED			
R. Bennett		737.78		735.33		12.82'/722.51' 6/1/88			

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	14	2 4 5	735				OL		TOPSOIL: clayey humus, trace roots, low plasticity, moist, trace oxidized nodules, black	
2	SS	18	4 4 6							trace lignite and mottling, dark gray	
3	SS	18	4 4 5	730	5			CL		SILTY CLAY: trace silt and lignite fragments, low plasticity, moist, abundant mottling, medium gray	
4	SS	18	1 2 1					CL		high plasticity, wet, dark gray	
5	SS	18	4 3 2	725	10			SM		SAND: fine to medium, well sorted, trace silt and lignite alluvium lenses, saturated, abundant mottling, medium gray	
6	SS	10	3 1 1					SM			
7	SS	18	1 1/2 1/2	720	15			SM		fine, very silty, interlayered silty clay lenses	
8	SS	18	1 1 1					SM		continued interlayered silty clay	

WESTON 01586 SS = SPLIT SPOON D = REMISION		SY = SHELBY TUBE C = CORE CT = CUTTINGS		CS = CONTINUOUS SAMPLER OT = OTHER		LCAAP Independence, Mo.		PAGE NO.	HOLE NO.
								1 of 2	14-3



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 2	HOLE NO. 14-3
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCK#	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
				715						End of boring 20.5 feet			

SYMBOLS ST = SOFT TUBE CT = CONTINUOUS SAMPLER CS = CORE CT = CUTTING ST = SOFT TUBE				LCAAP Independence, Mo.				PAGE NO. 2 of 2	HOLE NO. 14-3
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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 4	14-4		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/17/88	2/18/88	Layne-Western	Gardner-Davv 500	8"	.4" PVC	78.50'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		738.60	736.13	13.78'/722.35' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY -	SAMPLE BLOWNR	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
				735							
					5						
				730							
					10						
				725							
					15						
				720							

FASTN D1585 SY = SHELBY TUBE
SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
D = DEBRIS CT = CUTTINGS OT = OTHER

LCAAP
Independence, Mo.

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		2 of 4	14-4				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	INTERVAL	DESCRIPTION	NOTES
1	SS	12	17 21 20	715				SM		SAND: fine, well sorted, trace silt and lignite alluvium, saturated, medium brown	
					25						
				710							
2	SS	14	7 6 12					SM		medium grained	
					30						
				705							
3	SS	14	20 36 38					SM		fine grained	
					35						
				700							
4	SS	16	14 19 21					SM		fine to medium	
					40						
				695							

WESTON DYSOS
SS = SPLIT SPOON
O = REMILSON

ST = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
14-4



GEOLOGIC DRILL LOG						PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 3 of 4	HOLE NO. 14-4	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV.	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
5	SS	16	6 12 14		45			SM	SAND: fine to medium, moderately sorted, trace silt and fine gravel, saturated, medium brown with interbedded lignite alluvium lenses	
				690						
6	SS	4	9 11 12		50			SM	fine to coarse, poorly sorted, trace silt and coarse gravel	
				685						
7	SS	1	12 12 12		55			SM	same as above	
				680						
8	SS	14	14 14 18		60			SM	fine to medium, moderately sorted, trace silt, fine gravel and lignite alluvium	
				675						
9	SS	18	13					SM	SAND: fine to medium, moderately sorted, trace silt and coarse sand, thin lenses of lignite alluvium	

* WITH DYES
 SS = SPLIT SPOON
 S = SENSITIVE
 ST = SPLIT TUBE
 C = CORE
 CT = CUTTING
 CS = CONTINUOUS SAMPLER
 OT = OTHER



<div style="display: flex; justify-content: space-between;"> GEOLOGIC DRILL LOG PROJECT NAME AND LOCATION LCAAP, Independence, Mo. </div>										PAGE NO. 4 of 4	HOLE NO. 14-4
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
			12	670	65					satuated, medium brown	
10	SS	12	12 13 15		70			SM		fine to coarse, poorly sorted, no lignite	
11	SS	10	15 12 11		75			SM		same as above	
				660						LIMESTONE End of boring @ 78.5 feet	

WASHN DYSMS SY = SNELBY TUBE
 SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER
 D = DENNISON CT = CUTTINGS OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
14-4



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. HOLE NO. 1 of 5 16-6			
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
1/21/88	1/23/88	Layne-Western	Gardner Davr 500	7 7/8"	4" PVC	94.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
P. Bartz		740.73	738.30	13.43'/724.87' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
				735	5					FOR INFORMATION FROM 0 - 30 FEET, SEE GEOLOGIC LOG 16-7	
				730	10						
				725	15						
				720							

WESTON SYSTEMS
 SS = SPLIT SPOON
 C = CORE
 CT = CUTTING

ST = SHELBY TUBE
 C = CORE
 CT = CUTTING

CS = CONTINUOUS SAMPLER
 OT = OTHER

LCAAP
 Independence, Mo.

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 1 of 5 16-6



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				2 of 5	16-6		
SAMPLE NO.	SAMPLE TYPE	RECOVERY - %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
					715						
					25						
					710						
					30						
					705						
1	SS	10	18 16 16		35			SM		SAND: medium, well sorted, loose, subrounded, wet, gray	
					700						
2	SS	14	9 9 10		40			SM		fine grained	

WASH BY 506
SS = SPLIT SPOON
C = CORE
CT = CUTTINGS
OT = OTHER

SY = SHELBY TUBE
C = CORE
CT = CUTTINGS
OT = OTHER

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
16-6



<div style="display: flex; justify-content: space-between;"> <div style="width: 35%;"> GEOLOGIC DRILL LOG </div> <div style="width: 35%;"> <small>PROJECT NAME AND LOCATION</small> LCAAP, Independence, Mo. </div> <div style="width: 15%;"> <small>PAGE NO.</small> 3 of 5 </div> <div style="width: 15%;"> <small>HOLE NO.</small> 16-6 </div> </div>										
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
3	SS	10		695				SM	interbedded SAND and CLAY: sand is fine to medium, well sorted and rounded, loose, wet, gray; clay is silty, very soft, saturated, thin lenses, gray, trace wood debris	
4	SS	13	11 11 13	690				SM	same as above	
5	SS	9	14 14 17	685				SM	same as above	
6	SS	7	9 10 11	680				SM	medium to coarse grained, large fragments of lignite	
7	SS	8	14	675				SM	well sorted, medium grained	

WASH BY SIEVE
SS = SPLIT SPOON
C = CORRECTION
CT = CUTTING OF

SY = SHELBY TUBE
C = CORRECTION
CS = CONTINUOUS SAMPLER
CT = CUTTING OF
OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO.
16-6



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		4 of 5	16-6				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
			18		65						
8	SS	8	12 17 14	670	70			SM		same as above silty clay lense at 70' is very soft	
9	SS	8	23 13 14	665	75			SM		SAND: medium, well sorted and rounded, loose, wet, gray	
10	SS	8	12 12 17	660	80			SM		same as above	
11	SS	12	13 19 20	655	85			SM		abundant lignite alluvium in thin layers	

WESTON SYSTEMS

SS = SAND
S = SILT
CL = CLAY

BT = BENTONITE
C = CORE
CT = CONTINUOUS TUBES

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

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HOLE NO. 16-6



GEOLOGIC DRILL LOG						PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 5 of 5	HOLE NO. 16-6	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
12	SS	3	13 50/2"	650			Sh		SHALE: weathered surface, sandy, slightly fissile	
13	SS	0	100/2"	645			Sh		SHALE: as above, no recovery	
									End of boring @ 94.0 feet	NO RECOVERY

ST = SHELBY TUBE
 SS = SPLIT SPOON
 C = CORE
 CS = CONTINUOUS SAMPLER
 CT = CUTTING
 OT = OTHER

LCAAP
 Independence, Mo.

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HOLE NO.
 16-6



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 1 of 2	HOLE NO. 16-7		
START 1/20/88	FINISH 1/21/88	DRILLER Layne-Western.	DRILL METHOD CME 750 HSA	BOREHOLE DIAMETER 10"	WELL DIAMETER 4" PVC	TOTAL DEPTH 30.00'					
LOGGER P. Bartz		TOP OF CASING ELEV. 740.27	GROUND ELEVATION 738.26	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED 12.37'/725.89' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	8	6 7 16	735		[Pattern: Horizontal lines]	[Pattern: Vertical lines]	OL		TOPSOIL: silty loam, well sorted, moist, dark brown	
2	SS	17	5 5 15		5	[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		SILTY CLAY: well sorted, abundant silt, low plasticity, moist, trace mottling, dark gray-brown	
3	SS	17	3 4 6			[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		same as above	
4	SS	17	4 4 6	730	10	[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		trace roots	
5	SS	17	5 7 10			[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		some mottling	
6	SS	18	2 3 4	725	15	[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		thin lense of very soft clay	
7	SS	18				[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		trace fine sand, moderate plasticity, abundant mottling	
8	SS	18	3 2 1	720		[Pattern: Diagonal lines]	[Pattern: Vertical lines]	CL		trace medium sand, wet	

SS = SPLIT SPOON
 OL = OPEN LOG
 ST = SPLIT TUBE
 C = CONTINUOUS
 CT = CONTINUOUS TUBE
 CS = CONTINUOUS SAMPLER
 CL = CONTINUOUS LOG

LCAAP
 Independence, Mo.

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 HOLE NO. 16-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 2	HOLE NO. 16-7				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLAND	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	18	1 1 1					CL		trace fine sand, high plasticity, some thin silt lenses, wet, gray	
10	SS	18	3 5 6	715				ML		CLAYEY SILT: some clay, semi-soft, saturated, gray	
					25						
										SAND: fine to medium, well sorted, trace silt and clay, saturated, gray	
11	SS	16		710				SM			
					30					End of boring @ 30.0 feet	

SS = SPLIT SPOON
 C = CORE
 CT = CUTTING
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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Independence, Mo.

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HOLE NO.
16-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.
				LCAAP, Independence, Mo.		1 of 2	16-8
START	FINISH	DRIILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH	
1/21/88	1/22/88	Layne-Western	B-61/HSA	12"	4" PVC	24.00'	
LOGGERS		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED			
R. Bennett		749.94	747.10	12.56'/734.54' 6/1/88			

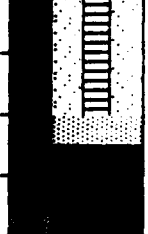
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	10	2 3 6	745				OL		TOPSOIL: clayey humus, some roots, semi-soft, moist, dark gray to black	
2	SS	12	5 10 8		5					trace red staining	
3	SS	18	2 4 6	740				CL		CLAY: trace lignite fragments, moderate plasticity, moist, brown, may be disturbed	
4	SS	18	2 2 1		10			CL		high plasticity	
5	SS	18	1 1 1	735				CL		wet, undisturbed	
6	SS	18	1 1 2		15			CL		trace silt	
7	SS	18	2 2 2	730				CL		trace fine gravel	
8	SS	18	2 2 2					CL		no gravel	

WESTON 015326
 SS = SPLIT SPOON
 OL = OLIVE
 SY = SHELBY TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 CT = CUTTING
 OT = OTHER

LCAAP
 Independence, Mo.

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 HOLE NO.
 16-8



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.
										LCAAP, Independence, Mo.		2 of 2	16-8
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES			
9	SS	18	2 2 2	725			CL		trace silt and sand, trace lignite fragments, trace mottling, brown				
									End of boring @ 24.0 feet				

LCAAP Independence, Mo.										PAGE NO. 2 of 2	HOLE NO. 16-8
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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 1 of 3	HOLE NO. 16-9		
START 1/27/88	FINISH 1/27/88	DRILLER Layne-Western	DRILL METHOD Gardner-Davv 500	BOREHOLE DIAMETER 7 7/8"	WELL DIAMETER 4" PVC	TOTAL DEPTH 50.00'					
LOGGER P. Bartz		TOP OF CASING ELEV. 750.01	GROUND ELEVATION 747.10	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED 22.28'/724.82' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
				745						FOR INFORMATION FROM 0 - 20 FEET, SEE GEOLOGIC LOG 16-8	
					5						
				740							
					10						
				735							
					15						
				730							

SS = SPLIT SPOON
 C = CONTINUOUS SAMPLER
 CT = CONTINUOUS CUTTING

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HOLE NO.
16-9



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		2 of 3	16-9				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	INTERVAL	DESCRIPTION	NOTES
1	SS	16	2 2 1		725			CL		SILTY CLAY: abundant silt, well sorted, soft, saturated, trace mottling, brown	
2	SS	18	1 1 2		720			CL		very moist, gray	
3	SS	18	1 1 1		715			CL		some silt, abundant wood debris, very soft	
4	SS	16	1 1 1		710			CL		very silty, trace pebbles	

WASH 01525 ST = SPLIT TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

CL = CLAYSTONE OT = OTHER

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Independence, Mo.

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 3 of 3	HOLE NO. 16-9		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
5	SS	14	10 8	705				SM		SAND: fine, well sorted, rounded, loose, wet, gray	
6	SS	6	14 18 17	700				Sh		SHALE: weathered surface, fissile, trace sand, blue-green	
					50					End of boring @ 50.0 feet	

SS = SPLIT SPOON
 C = CORE
 CT = CUTTING
 ST = SHELBY TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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HOLE NO.
16-9



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 3	16-10		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
1/27/88	2/2/88	Layne-Western	ATV/Tri-cone	8"	4" PVC	64.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
P. Bartz		765.45	762.70	14.86'/747.84' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	4	3 2 3	760				CL		SILTY CLAY: well sorted, soft, semi-moist, dark brown	
2	SS	15	3 4 5		5			CL		abundant black metallic small rounded concretions, brown matrix, semi-soft, cohesive, semi-moist	
3	SS	18	3 3 2	755				CL		much black mottling, some red-brown mottling, trace small deposits of very fine buff sand, uniform texture, semi-soft	
4	SS	17	3 3 3		10			CL		semi-moist with some wet zones, some dark gray silty clay where wet	
5	SS	18		750				CL		more silt, lighter red-brown	
6	SS	18	3 4 6		15			CL		oily sheen on sample	
7	SS	16	3 3 10	745				CL		more silt	
8	SS	18	5 10 15					ML		CLAYEY SILT: firm, slightly shaley, drier, red-brown with occasional gray and dark gray zones	

*ASTM D1586
 SS = SPLIT SPOON
 D = DIRMASON
 ST = SHELBY TUBE
 C = CORE
 CT = CUTTINGS
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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 HOLE NO.
 16-10



GEOLOGIC DRILL LOG					PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 3	WELL NO. 16-10		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	8	49 50/3"	740				ML	SILT: with clay, very compact, firm, crumbly, thinly bedded with dark laminations, semi-dry, light brown, may be weathered shale	
10	SS	8	50 44	735				ML	some thin beds of maroon silt, overall olive-green	
11	SS	4	100/4"	730				Sh	SHALE: well sorted, uniform texture, semi-hard, blue-green	
12	SS	0	50/0"	725				Sh	same as above	
CT					40			Sh		

*ASTM D1586
 SS = SPLIT SPOON
 D = DENNISON

ST = SHELBY TUBE
 C = CORE
 CT = CUTTINGS

CS = CONTINUOUS SAMPLER
 OT = OTHER

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16-10



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.		3 of 3	16-10		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS*	DEPTH FEET	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
				720				observed cuttings 39.0 - 64.0 feet SHALE: silty, variable hardness, uniform grain size and texture, blue-green	
				45					
	CT			715				same as above	
				50			Sh		
				710				same as above	
				55					
				705				same as above	
				60					
	CT			700			Ls	LIMESTONE	
End of boring @ 64.0 feet									

*ASTM D1586
 SS = SPLIT SPOON
 D = DENNISON
 SY = SHELBY TUBE
 C = CORE
 CT = CUTTINGS
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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 Independence, Mo.

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 HOLE NO.
 16-10



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.		HOLE NO.	
LCAAP, Independence, Mo.				1 of 3		16-11					
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/3/88	2/4/88	Layne-Western	Gardner-Davv 500	8"	4" PVC	63.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
P. Bartz		765.06	762.90	43.15'/719.75' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWB	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	14	8 13 15	760	5			CL		SILTY CLAY: moderately sorted, uniform texture and grain size, semi-moist, firm, semi-plastic, tan-brown, abundant black metallic rounded concretions	
2	SS	17	7 8 11	755	10			CL		more silt, very firm, less plastic, no concretions, lighter tan-brown, olive	
3	SS	18	7 9 13	750	15			CL		very silty, buff	
4	SS	12	29 29 50/3"	745				CL		semi-brittle, very dense, some red-brown mottling	

SS = SPLIT SPOON
 C = CORE
 CT = CUTTING
 ST = SHELBY TUBE
 CS = CONTINUOUS SAMPLER
 OF = OTHER

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 Independence, Mo.

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HOLE NO.
 16-11



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		2 of 3	16-11				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
5	SS	3	50/3"	740				Sh		same as above	
	CT				25			Sh		SHALE: uniform grain size and texture, thinly bedded, crumbly along bedding plane, semi-weathered, dry, gray, occasional thin brown beds	
				735							
					30					maroon colored 30 - 31 feet	
										gray color	
	CT				35			Sh			
				730							
				725						shale becoming harder, also observed small globules of oil in drill mud	
					40						

*ASTM D1585
 SS = SPLIT SPOON
 D = DENNISON
 ST = SHELBY TUBE
 C = CORE
 CT = CUTTINGS
 CS = CONTINUOUS SAMPLER
 OT = OTHER

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	WELL NO.				
				LCAAP, Independence, Mo.		3 of 3	16-11				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
	CT			720						olive green-gray	
					45			Sh			
					715						
	CT				50						
					710						
	CT				55			Sh		Observed cuttings 24.0 to 61.0 feet	
					705						
	CT				60			La		LIMESTONE: massive, hard, gray	
					700					End of boring 63.0 feet	

WASH DYES ST = SHELBY TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

D = DENLISON CT = CUTTINGS OT = OTHER

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GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.
										LCAAP, Independence, Mo.		1 of 2	16-12
START	FINISH	DRILLER		DRILL METHOD		BOREHOLE DIAMETER		WELL DIAMETER		TOTAL DEPTH			
1/23/88	1/27/88	Layne-Western		B-61/HSA		12"		4" PVC		32.00'			
LOGGER		TOP OF CASTING ELEV.		GROUND ELEVATION		DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		776.17		773.80		14.15'/759.65' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
1	SS	18	7 22 14					FILL		FILL: clay with trace silt, abundant carbonized nodules, very stiff, moist, abundant oxidized staining, red-brown			
2	SS	18	8 14 15	770	5					trace fine gravel			
3	SS	18	5 7 9					CL		CLAY: well sorted, trace silt, low plasticity, moist, trace mottling, red-brown			
4	SS	18	5 6 8	765	10			CL		more moist and plastic			
5	SS	18	4 9 11					CL		trace lignite fragments and roots, less moist and plastic			
6	SS	18	5 9 14	760	15			CL		trace gravel, becomes layered gray and brown, becomes very stiff, may be claystone or weathered shale			
7	SS	18	17 38 46					Sh		SHALE: same character as above, more cohesive, firm, gray and brown			
8	SS	10	45 50/5"	755				Sh		gray			

WASH 01505
SS = SPLIT SPOON
O = OBSERVATION

ST = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

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GEOLOGIC DRILL LOG		PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.					
		LCAAP, Independence, Mo.		2 of 2	16-12					
SAMPLE NO.	SAMPLE TYPE	RECOVERY -	SAMPLE BLOWS	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	2	50/6"	750			Sh		SHALE: fine, well sorted, fissile, light gray	
				25						
10	SS	2	50/2"	745			Sh		same as above	
				30						
									End of boring @ 32.0 feet	

SS = SPLIT SPOON ST = SHELBY TUBE CS = CONTINUOUS SAMPLER
 S = SENSATION CT = CUTTING OT = OTHER

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 Independence, Mo.

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 16-12



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	WELL NO.
				LCAAP, Independence, Mo.				1 of 1	16-13
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH			
1/24/88	1/24/88	Layne-Western	ATV/HSA	10"	4" PVC	20.00'			
LOGGER		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED					
R. Bennett		775.40	773.38	7.83'/765.55' 6/1/88					

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	8	12 20 30					FILL		FILL: clay, trace fine gravel and roots, very stiff, moist, trace mottling	
2	SS	14	6 8 8	770	5					abundant lignite fragments, gray and brown	
3	SS	18	4 4 5					CL		CLAY: well sorted, stiff moist, trace mottling, red-brown	
4	SS	18	4 4 3	765	10			CL		moderate plasticity, wet	
5	SS	0	3 3 4					CL			NO RECOVERY
6	SS	18	2 2 8	760	15			CL		abundant lignite fragments, gray	
7	SS	18	7 4 6					CL		trace silt, moist to wet	
8	SS	18	1					CL		SILTY CLAY: abundant silt, trace fine gravel, moderate plasticity, very moist, some oxidation and mottling, gray	
End of boring @ 20.0 feet											

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.
				LCAAP, Independence, Mo.				1 of 1	17-7
START	FINISH	DRILLER	DRILL METHOD	BORERHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH			
1/20/88	1/20/88	Layne-Western	B-61/HSA	12"	4" PVC	17.50'			
LOGGERS		TOP OF CASTING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED					
R. Bennett		740.05	737.45	11.91'/725.54' 6/1/88					

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE ELONGER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	10	2 6	735				OL	TOPSOIL: silt, clay, humus, roots, moist, dark gray	
2	SS	12	2 3		5					
3	SS	18	2 1 3	730				CL	CLAY: trace silt, fine gravel and lignite fragments, moderate plasticity, saturated, some mottling, dark gray to black	
4	SS	18	2 1 1		10			CL	some thin silt lenses, saturated	
5	SS	18	2 2 1	725				CL	no gravel, saturated	
6	SS	18	2 2 1		15			CL	abundant lignite fragments	
7	SS	18	2 2 2	720				CL	some silt, no lignite, saturated	
									End of boring @ 17.5 feet	

SS = SPLIT SPOON
 OL = OIL
 SY = SHELBY TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 CT = CUTTING
 OT = OTHER

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Independence, Mo.

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HOLE NO. 17-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 5	17-8		
START	FINISH	DRILLER	DRILL METHOD	BOREROLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
1/24/88	1/26/88	Layne-Western	Gardner-Davv 500	8"	4" PVC	86.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
P. Bartz		740.04	737.45	10.67'/726.78' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCK#	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
				735							
					5						
				730							
					10						
				725							
					15						
				720							
1	SS	18						CL			
										FOR INFORMATION FROM 0 - 15 FEET, SEE GEOLOGIC LOG 17-7	
										SILTY CLAY: well sorted, some brown mottling, soft, very moist to wet, gray	

FASTN 01585
SS = SPLIT SPOON
D = DEBRIS

SY = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		2 of 5	17-8				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
2	SS	18	5 11 11	715	25			CL		very silty, silty sand lense at 24.5', very soft	
3	SS	6	1 2 2	710	30			SM		SAND: medium, well sorted and rounded, abundant silt, grades to clean sand at 29.0', wet, loose, gray	
4	SS	6	12 12 14	705	35			SM		trace small pebbles	
5	SS	8	14 26 26	700	40			SM		SAND: medium, well sorted, abundant silt, trace of fine gravel, saturated, medium gray	

WESTON DTS-500

SS = SPLIT SPOON

D = DENNISON

ST = SHELBY TUBE

C = CORE

CT = CUTTINGS

CS = CONTINUOUS SAMPLER

OT = OTHER

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Independence, Mo.

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GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		3 of 5	17-8				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLANKS	ELEV.	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS-IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
6	SS	12	11 13 8	695				SM		SAND: medium, well sorted, interlayered with beds of fine sand with abundant silt, saturated, medium gray	
7	SS	5	17 24 24	690	45			SM		same as above, trace of fine gravel	
8	SS	12	18 27 21	685	50			SM		SAND: same as above, fine grained	
9	SS	5	13 14 18	680	55			SM		SAND: medium to coarse, moderately sorted, some gravel, trace lignite alluvium, loose, wet, gray	
10	SS	7	12	675	60			SW		SAND and GRAVEL: coarse grained, poorly sorted, trace shale fragments, loose, wet, gray	

WESTON 015286
 SS = SPLIT SPOON
 D = REEPLUG
 SY = SHELBY TUBE
 C = CORE
 CT = CUTTING
 CS = CONTINUOUS SAMPLER
 OF = OTHER

LCAAP
 Independence, Mo.

PAGE NO.
 3 of 5
 HOLE NO.
 17-8



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		4 of 5	17-8				
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
			12		65					see above	
11	SS	3	17 21 9	670	70			SW		more gravel	
12	SS	7	15 21 20	665	73			SM		SAND: medium to coarse, moderately sorted, trace gravel, subrounded, loose, wet, gray	
13	SS	18	6 5 11	660	80			ML		SILT: well sorted, thinly bedded, semi-soft, semi-moist, gray	
14	SS	6	20 13 11	655	85			ML		with some coarse sand and gravel, medium to coarse, wet, gray	

FASTN 01505 SY = SHELBY TUBE

SS = SPLIT SPOON C = CORE CS = CONTINUOUS SAMPLER

0 = DEBRIS CT = CUTTINGS OT = OTHER

LCAAP
Independence, Mo.

PAGE NO. HOLE NO.

4 of 5 17-8



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.
										LCAAP, Independence, Mo.		5 of 5	17-8
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOCKS*	ELV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
										Interbedded LIMESTONE and SHALE End of boring @ 86.0 feet			

*ASTM D1585 SS = SPLIT SPOON D = DENNISON				SY = SHELBY TUBE C = CORE CT = CUTTINGS				CS = CONTINUOUS SAMPLER OT = OTHER				LCAAP Independence, Mo.		PAGE NO. 5 of 5	HOLE NO. 17-8
---	--	--	--	---	--	--	--	---------------------------------------	--	--	--	----------------------------	--	--------------------	------------------



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 2	17-9		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
1/22/88	1/22/88	Layne-Western	B-61/HSA	12"	4" PVC	20.50'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
R. Bennett		748.60	746.10	7.23'/738.87' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	5	3 6 8	745				OL		TOPSOIL: clayey humus with some roots, well sorted, moist, dark brown to black	
2	SS	6	3 4 5		5			CL		CLAY: well sorted, trace lignite fragments, low plasticity, moist, trace mottling, red-brown	
3	SS	16	2 3 2	740				CL		same as above	
4	SS	18	1 2 1		10			CL		moderate to high plasticity, saturated	
5	SS	18	2 2 2	735				CL		SILTY CLAY: well sorted, high plasticity, saturated, some mottling, red-brown	
6	SS	18	2 2 3		15			CL		abundant lignite, medium gray	
7	SS	18	4 4 6	730				CL		same as above	
8	SS	18	5 7 10					CL		trace mottling	

SS = SPLIT SPOON
 OL = OLIVE
 CT = CUTTINGS

ST = SHELBY TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 OT = OTHER

LCAAP
Independence, Mo.

PAGE NO. 1 of 2

HOLE NO. 17-9



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.
										LCAAP, Independence, Mo.		2 of 2	17-9
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
										End of boring @ 20.5 feet			

WASH DYSDB	SY = SHELBY TUBE	LCAAP		PAGE NO.	HOLE NO.
SS = SPLIT SPOON	C = CORE	Independence, Mo.		2 of 2	17-9
D = DEINELSON	CT = CUTTINGS				
	CS = CONTINUOUS SAMPLER				
	OT = OTHER				



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 1 of 2	HOLE NO. 17-10
START 1/26/88	FINISH 1/26/88	DRILLER Layne-Western	DRILL METHOD ATV (CME)/HSA	BOREHOLE DIAMETER 10"	WELL DIAMETER 4" PVC	TOTAL DEPTH 28.00'			
LOGGER P. Bartz		TOP OF CASING ELEV. 748.14	GROUND ELEVATION 745.40	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED 19.97'/725.43' 6/1/88					

SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE IN CHARGE	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
				745							
					5						
				740							
					10						
				735							
					15						
				730							
1	SS	16	11 14 17					CL		SILTY CLAY: well sorted, abundant silt, trace roots, mottled red-brown and gray, semi-firm, semi-plastic, semi-moist	

WASH BY SIEVE	ST = SPLIT TUBE	CS = CONTINUOUS SAMPLER	LCAAP Independence, Mo.	PAGE NO. 1 of 2	HOLE NO. 17-10
SS = SPLIT SPOON	C = CORE	CT = CUTTING			
D = DREDGE	OT = OTHER				



GEOLOGIC DRILL LOG					PROJECT NAME AND LOCATION			PAGE NO.	HOLE NO.		
					LCAAP, Independence, Mo.			2 of 2	17-10		
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS*	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
2	SS	18	7 10 13	725				CL		more mottling and carbonized wood fragments	
				720	25					LIMESTONE: fissile, hard, gray	
										End of boring @ 28.0 feet	

*ASTM D1585
 SS = SPLIT SPOON
 D = DENSITOMETER
 ST = SHELBY TUBE
 C = CORE
 CT = CUTTINGS
 CS = CONTINUOUS SAMPLER
 OT = OTHER

LCAAP
 Independence, Mo.

PAGE NO. HOLE NO.
 2 of 2 17-10



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION				PAGE NO.	HOLE NO.		
				LCAAP, Independence, Mo.				1 of 5	18-7		
START	FINISH	DRILLER	DRILL METHOD	BOREHOLE DIAMETER	WELL DIAMETER	TOTAL DEPTH					
2/7/88	2/8/88	Layne-Western	Gardner-Dann 500	8"	4" PVC	94.00'					
LOGGER		TOP OF CASING ELEV.	GROUND ELEVATION	DEPTH/ELEVATION GROUNDWATER - DATE MEASURED							
P. Bartz		739.26	737.40	12.41'/724.99' 6/1/88							
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
1	SS	12	3 8 9	735	5			CL		SILTY CLAY: well sorted, abundant silt and roots, uniform texture, stiff, some mottling, semi-moist, dark gray	
2	SS	17	5 6 7	730	10			CL		same as above	
3	SS	18	1 1 2	725	15			ML		CLAYEY SILT: poorly sorted, some clay and very fine sand, abundant roots, increased silt at 15.0', soft, some mottling, very moist, dark gray	
4	SS	17	4 3 1	720				CL		SILTY CLAY: moderately sorted, semi-firm, semi-moist, some mottling, gray	

WASH 01586
 SS = SPLIT SPOON
 D = DENNISON

ST = SHELBY TUBE
 C = CORE
 CT = CUTTINGS

CS = CONTINUOUS SAMPLER
 OT = OTHER

LCAAP
 Independence, Mo.

PAGE NO.
 1 of 5

HOLE NO.
 18-7



GEOLOGIC DRILL LOG						PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 2 of 5	HOLE NO. 18-7	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOWER	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	INTERNAL	DESCRIPTION	NOTES
5	SS	18	3 3 3	715			CL		interbedded CLAY and SILT: semi-soft, moderately sorted, very moist, gray	
6	SS	10	3 16 31	710			SM		SAND: clayey silt grades down to fine sand, well sorted, rounded, loose, wet, gray	
7	SS	3	11 20 24	705			SM		interbedded SILT, CLAY, and SAND: thinly bedded, all soft, wet, gray, with abundant woody plants	
8	SS	14	9 9 13	700			SM		SAND: fine, well sorted, rounded, loose, wet, green-gray	
<div style="display: flex; justify-content: space-between;"> <div> *ASTM D1586 SS = SPLIT SPOON R = REMOVED </div> <div> ST = SHELBY TUBE C = CORE CT = CUTTINGS </div> <div> CS = CONTINUOUS SAMPLER OT = OTHER </div> </div>										
LCAAP Independence, Mo.								PAGE NO. 2 of 5	HOLE NO. 18-7	



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION LCAAP, Independence, Mo.				PAGE NO. 3 of 5	HOLE NO. 18-7	
SAMPLE NO.	SAMPLE TYPE	RECOVERY %	SAMPLE BLOBS*	DEPTH F	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
9	SS	8	11 20 24	695			SM		SAND: fine, well sorted, saturated, green-gray	
10	SS	9	10 19 23	690			SM		same as above	
11	SS	0	22 23 31	685			SM			NO RECOVERY
12	SS	9	33 23 27	680			SM		SAND: fine to medium, well sorted, trace of coarse sand and fine gravel, saturated, medium gray	
13	SS	11	22	675			SM		SAND: fine to medium, fairly sorted, abundant lignite alluvium, trace large gravel, saturated, gray	

*ASTM D1585
SS = SPLIT SPOON
0 = DEBRIS

ST = SHELBY TUBE
C = CORE
CT = CUTTINGS

CS = CONTINUOUS SAMPLER
OT = OTHER

LCAAP
Independence, Mo.

PAGE NO.
3 of 5

HOLE NO.
18-7



GEOLOGIC DRILL LOG				PROJECT NAME AND LOCATION		PAGE NO.	HOLE NO.				
				LCAAP, Independence, Mo.		4 of 5	18-7				
SAMPLE NO.	SAMPLE TYPE	RECOVERY -	SAMPLE BLOBS	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASS- IFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES
14	SS	11	23 25 27	670	65			SM		see above	
15	SS	6	10 20 21	665	70			SM		same as above	
16	SS	18	1 1 7	660	75			CL		fine to coarse, trace lignite and fine gravel, very fine sand at 75.0'	
17	SS	10	14 18 26	655	80			SM		CLAY: well sorted, plastic, very uniform texture, semi-soft, very moist, gray, becomes silty at 80.0'	
					85					SAND: fine to medium, poorly sorted, abundant lignite alluvium, trace limestone fragments, loose, wet, gray	

WASH 01525

SS = SPLIT SPOON

D = DEBRIS

ST = SPLIT TUBE

C = CORE

CT = CUTTING

CS = CONTINUOUS SAMPLER

OT = OTHER

LCAAP

Independence, Mo.

PAGE NO.

4 of 5

HOLE NO.

18-7



GEOLOGIC DRILL LOG										PROJECT NAME AND LOCATION LCAAP, Independence, Mo.		PAGE NO. 5 of 5	HOLE NO. 18-7
SAMPLE NO.	SAMPLE TYPE	RECOVERY -	SAMPLE BLOWER	ELEV	DEPTH	GRAPHIC LOG	WELL CONSTRUCTION	CLASSIFICATION	SAMPLE INTERVAL	DESCRIPTION	NOTES		
18	SS	9	45 55/3"		650			SM		fine, well sorted, trace lignite alluvium, subangular, tightly packed, wet, gray			
19	SS	3	80/3"		90			SM		weathered surface of quartz and limestone rock			
					645					LIMESTONE: hard, massive, fractured, gray End of boring @ 94.0 feet			

WESTON OYSES
 SS = SPLIT SPOON
 C = CORE
 CT = CUTTINGS
 SY = SHELBY TUBE
 C = CORE
 CS = CONTINUOUS SAMPLER
 OT = OTHER

LCAAP
 Independence, Mo.

PAGE NO.
 5 of 5

HOLE NO.
 18-7

**WELL CONSTRUCTION RECORDS OF
PREVIOUSLY EXISTING LCAAP WELLS**

A0039



LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.0

Reference Elevation: _____

Reference Description: Mark on REC 2M

JOB NO.	CLIENT	LOCATION
THAST132	USATHAMA	LCAAP
DRILLING METHOD: <u>Hand Driven Auger</u>		BORING NO.
<u>12" O.D., 6.5" I.D.</u>		<u>86-03</u>
<u>CMS 55 RIG</u>		SHEET
SAMPLING METHOD: <u>STAND. PENETRATION</u>		<u>1 of 2</u>
TEST - <u>18" driven split spoon - 200</u>		
<u>120 lb hammer fell 50"</u>		
WATER LEVEL	TIME	DATE
<u>5.45</u> <u>8.01</u>	<u>1305</u> <u>1615</u>	<u>5-8-96</u> <u>5-3-96</u>
REFERENCE	DATE	DATE
<u>REF</u> <u>REF</u>	<u>5-8-96</u>	<u>5-3-96</u>

SAMPLE TYPE	INCHES DEPTH	DEPTH OF CASING	SAMPLE NO.	BLOWS/IN. SAMPLE	R.I.D. ppm	DEPTH IN FEET	GRAPHIC LOG	SURFACE CONDITIONS
ST	1.3	0	1	1.0	0	0	ML	overgrown light - near tree
	2.3					1		line a base of incision
						2		
						3		
						4		
ST	1.5	45	2	3	0	5	ML	Moist medium slight clayey silt, trace fine sand ML
	1.5			3		6		olive gray - SY 3/2 (GSA)
				4		7		
						8		
						9		
ST	1.5	9.5	3	2	0	10	ML	Moist medium slight clayey silt, trace fine sand ML
	1.5			2		11		Dark yellowish brown - 10 YR 4/2
				3		12		
						13		
						14		
ST	1.5	14.5	4	2	0	15	ML	Wet very soft clayey silt, trace fine sand ML
	1.5			1		16		Dark yellowish brown 10 YR 4/2
				2		17		
						18		
						19		
						20		

MW 16-3



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.		CLIENT		LOCATION	
THASIBZ		USATHAMA		LCARP	
DRILLING METHOD:				BORING NO.	
				86-03	
SAMPLING METHOD:				SHEET	
				2 of 2	
				DRILLING	
				START FINISH	
WATER LEVEL				TIME TIME	
TIME				TIME TIME	
DATE				DATE DATE	
REFERENCE					

DRILLING LOG

SAMPLE TYPE	WATER DEPTH	DEPTH OF CASING	WATER DEPTH	BLOWS IN SAMPLER	R.O. W.R.	DEPTH IN FEET	GRAPHIC LOG
SPT	1.5	19.5	5	2	0	1	ML
				3		2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						10	
						11	
						12	
						13	
						14	
						15	
						16	
						17	
						18	
						19	
						20	
						21	
						22	
						23	
						24	
						25	
						26	
						27	
						28	
						29	
						30	

SURFACE CONDITIONS:

Not soft clayey silt. trace fine sand
Vellousish brown 10 yr 5/2

ML Wet medium silt & clayey silt 1/16" & 1/8" sand, trace fine gravel. (dravel is pieces of gravel - not horiz. oriented)
Light olive gray - 5x 5/2
B.O.H @ 24.5 B.O. Sampling @ 26.0
Finished sampling @ 930

Well Installation: Total app = 25.5'
riser = 13.0' screen = 10.0' plugs 0.5'
2.0' stick up

- cleared out augers by 10 minine auger plug through auger cutting head
- pulled augers up several feet and placed basal sand pack 123.5-24.5'
- installed well through augers and placed sand pack up to 8.0' through augers
- pulled augers and placed bentonite pellets up to 22', then grout to surface
- protective casing w/ 1/2" SPT in grout

- 26 hrs - no grout settlement

DATE



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.5

Reference Elevation: _____

Reference Description: Mark on DC Rim

JOB NO.	CLIENT	LOCATION
THA5132	USATHAMA	LCARP
DRILLING METHOD: <u>Hy-Low Stem Auger</u>		BORING NO.
<u>12" O.D., 5.5" I.D.</u>		<u>86-04</u>
<u>CME 55 Rig</u>		SHEET
<u>1 of 2</u>		
SAMPLING METHOD: <u>Stand. Pen. Test</u>		DRILLING
<u>(SPT) 18" driven S.O.I.t. - 2001-</u>		START
<u>15lb hammer falling 30"</u>		FINISH
WATER LEVEL	<u>33.0</u>	<u>5.36</u>
TIME	<u>1755</u>	<u>1610</u>
DATE	<u>5-2-96</u>	<u>5-2-96</u>
REFERENCE	<u>REF</u>	<u>257</u>
		<u>5086</u>
		<u>583</u>

DRILLING CURVE - A) W. SEC.
BUCK BLANK

SAMPLER TYPE	DEPTH OF CASING	DEPTH OF SAMPLE	BLOWS/S IN SAMPLER	P.I.D	DEPTH IN FEET	DRILLING LOG
				ppm		
					0	
					1	
					2	
					3	
					4	
					5	
					6	
					7	
					8	
					9	
					10	
					11	
					12	
					13	
					14	
					15	
					16	
					17	
					18	
					19	
					20	

Surf. Conditions: Flat, overgrown field 15-20'
from locate stream - marsh area

Moist medium stiff clayey silt, trace fine sand ML
Light olive gray SY 5/2 (BSA)

Moist very stiff silty clay, trace fine sand CL
olive brown SY 5/5

Moist stiff silty clay tr. f. sand CL
Light olive brown SY 5/6
Auger scraped for several revolutions @ 11.5'

encountered H₂O on screen @ 15.2'

Moist/wet hard shaly clay some c- gravel (chert + seamm) little c- sand CL
Light olive brown yellow - SY 5/6
Sampled into hard weathered shale @ 15.9' (1.5' sand particles)

- Hard mudstone part 25'
- cased all water, little water was encountered above & continued dry hole

C-83 - SHEET

on 10-21-2011 AM
CWD BY [signature]
DATE



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.

THA5182

CLIENT

USATHANNA

LOCATION

LCRAP

DRILLING METHOD:

BOREHOLE NO.

B6-04

SAMPLING METHOD:

SHEET

2 of 2

WATER LEVEL

TIME

DATE

REFERENCE

DRILLING

START TIME

FINISH TIME

DATE DATE

SAMPLE TYPE	INITIAL DEPTH (ft)	DEPTH OF CASING (ft)	SAMPLE DEPTH (ft)	WLOWS/S IN SAMPLE	P.D. ppm	DEPTH IN FEET	GRAPING LOG
-------------	--------------------	----------------------	-------------------	-------------------	----------	---------------	-------------

SPT	1.5	19.5	5	23	0	20	CL
	1.5		20.5	31		21	
				36		22	

						23	
						24	
						25	
						26	
						27	
						28	
						29	
						30	

SPT	0.5	24.5	6	50.4	0	31	CL
	0.5		25.5			32	
						33	

						34	
						35	
						36	
						37	
						38	
						39	
						40	

SPT	1.4	29.5	7	13	0	41	CL
	1.4		30.5	25		42	
				30.4		43	

						44	
						45	
						46	
						47	
						48	
						49	
						50	

SPT	0.2	30.5	8	50.4	0	51	CL
	0.2		31.5			52	
						53	

						54	
						55	
						56	
						57	
						58	
						59	
						60	

SURFACE CONDITIONS:

Moist hard silt/clay - weathered shale w/ horizontal orientation. 2' chert stain @ 10.5-12.6'
Lt. olive gray yellow SY 6/3

Moist hard silt/clay (weathered shale w/ horizontal orientation)
Lt. olive gray brown SY 5/3

Moist hard weathered shale (silt/clay)
Med. dark gray - NG

Moist hard weathered shale (silt/clay CL)
Med. gray NS
- Finished sampling @ 10.15 - dry hole
- B.O.H. 34.5, B.O. Samp @ 32.9'
Well installation - 22.5' total O.D. 2.5" dia
2.0" pipe, 15.0' screen, 0.5' filter
Culled auger because hole was dry.
Placed 2.5' sand @ base + placed
EVC well cap + 2' sand 23.4' up to
10.5' - to interrupt any rock in stream
Placed concrete pellets to 5.5' then routing
to surface and set prot. casing w/ 100.

24 hrs - no amt settlement

Little Creek, CA

DATE CASH ID BY

1/1/84

BY

C-84



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.0

Reference Elevation: _____

Reference Description: Mark on PVC rim

JOB NO.	CLIENT	LOCATION
THASICZ	USATINAMA	LCAAP
DRILLING METHOD: <u>HSA - 12" O.D. 65" I.D.</u>		BORING NO.
<u>CME 55 RIG</u>		<u>BB-05</u>
SAMPLING METHOD: <u>Stand Pen. Test 18"</u>		SHEET
<u>driven split spoon 2' O.D. 100</u>		<u>1 of 2</u>
<u>16 hammer falling 30"</u>		DRILLING
WATER LEVEL	TIME	START
<u>19.82</u>	<u>1600</u>	TIME
DATE	DATE	DATE
<u>5-9-96</u>	<u>5-9-96</u>	<u>5-9-96</u>
REFERENCE	DATE	DATE
<u>REF</u>	<u>5-9-96</u>	<u>5-9-96</u>

SAMPLER TYPE	WATER	DEPTH OF CASING	SAMPLE NO.	BLOWS/IN. SAMPLER	DEPTH IN FEET	GRAPHIC LOG	SOIL CONDITIONS
SPT	1.5	0	1.0	10	0	CL	Moist stiff silty clay, trace c/sand, ir. fine gravel (RZ Fill) CL olive gray, 5X 4/2 (GSA)
SPT	1.5	4.5	2.5	5	0	ML	Moist very stiff clayey silt, trace f. sand, olive brown 5Y 3/3 gray
SPT	1.5	9.5	3.5	2	1	ML	Moist medium stiff clay on silt, trace fine sand ML - possibly saturated light olive gray 5Y 4/2
SPT	1.5	14.5	4.5	11	0	CL	Moist hard silty clay, tr. fine sand CL highly weathered olive gray 5Y 3/4

C-85

NEXT SHEET

MW16-5



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO. THA5132		CLIENT USATHAMA		LOCATION LCAAP	
DRILLING METHOD:				BORING NO. 86-05	
SAMPLING METHOD:				SHEET 202	
WATER LEVEL				START	FINISH
TIME				TIME	TIME
DATE				DATE	DATE
REFERENCE					

SAMPLE TYPE	DEPTH OF CASING	SAMPLE DEPTH	BLOWS/L. SAMPLE	P.D.	DEPTH IN FEET	GRAPING LOG	SURFACE CONDITIONS
SPT	1.5 1.2	19.5	14 20 31	0	20	CL	Moist hard silty clay - weathered shale w/ horizontal orientation Greenish blue 10Y 5/2
					1		Harder augering @ 22.0'
					2		
					3		
					4		
SPT	1.3 1.0	24.5	6 29 41 29/3	0	3	CL	Moist hard silty clay - weathered shale Greenish green 10GY 5/2 (Dark red SP-34 Silt) B.O. Hole @ 26.5', B.O. Sampling 25.8'
					6		Completed sampling @ 10.15' - hole still open
					7		B.O. Well - 23.5'
					8		
					9		Well Installation - 25.5' total PVC 15.0' casing, 10.0' screen, 0.5' plug 2.0' stickup
					30		- mixed auger 2-3.5' - removed out clay from auger head w/ auger plug
					1		- closed 1' sand at base
					2		- hit hole w/ 1/2" through auger
					3		- attempted to place sand pack through annulus, but got hung up on PVC
					4		- pulled auger and hole remained open - completed sand pack up to 9.0'
					5		- Bentonite pellets 3.0 to 3.0', then added 1/2" auger
					6		- place locking protective casing
					7		
					8		
					9		
					0		



EA ENGINEERING,
SCIENCE, AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.4

Reference Elevation: _____

Reference Description: Mark on Top of PVC casing

JOB NO.	CLIENT	LOCATION
THE 5156	USA TIRMA	CAFF / 2202 4
DRILLING METHOD:	G.S. HSA, 6" I.D.	BORING NO.
HSA CME 70	21K	87-01
SAMPLING METHOD:	SPT - Standard Penetration	SHEET
Test: 19" long split spoon (2" ID, 15" I.D.)		1 or 3
Driven by a 140 lb hammer free fall 30"		DRILLING
WATER LEVEL	21.5 18.2 17.82 18.04	START FINISH
TIME	1600 0805 1345 1130	TIME TIME
DATE	1/21 1-22 1-22 1-23	DATE DATE
REFERENCE	SUEF SUEF REF REF	1-21-87 1-21-87

SAMPLER TYPE	INCHES DEPTH	DEPTH OF CASING	SAMPLE DEPTH	BLOWS/S IN SAMPLER	DEPTH IN FEET	GRAPHIC LOG	SURFACE CONDITIONS:
							Engine / Ground covered dirt
							1.0 ft. deep vibrator case and fence
							Base 50' south.
SPT	18	0	1	3	0	0	ML Dk. Yell. brown moist med. sand, silty (10 YR 4/2)
				3		1	SW SP
				3		2	Light moist med. sand, trace silt (SW) (same)
						3	
						4	
						5	
SPT	18	5	2	6	0	5	SW SP
				6		6	Yellowish brown moist medium sand, silty (SW) (10 YR 6/4) (medium dense)
				9		7	
						8	
						9	
SPT	18	10	3	7	0	10	SW SP
				7		11	Dk. yellowish brown moist medium sand, silty (10 YR 4/4) (med. dense)
				8		12	
						13	
						14	
						15	
SPT	18	15	4	7	0	15	SW SP
				7		16	Yellowish orange med. fine sand, trace silt (2 YR 6/4) (med. dense)
				10		17	
						18	
						19	
						20	ML

DRILLING CONTINUED - Layer 18 ft. deep

DATE 1/22/87



Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO	CLIENT	LOCATION
THE SITE	USFTHMP	LEAMP/ACF/
DILLING METHOD:	NSA	BOILING NO
		87-01
		SHEET
SAMPLING METHOD:	SPT	2 of 3
		DILLING
		START TIME
		FINISH TIME
WATER LEVEL		
TIME		
DATE		
REFERENCE		
		DATE
		DATE*

[illegible]



EA ENGINEERING,
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LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.

THA 5136

CLIENT

USA - HAMA

LOCATION

WABP/HAMA

DRILLING METHOD:

SCHEMATIC

BT-01

SHEET

3 of 3

SAMPLING METHOD:

DRILLING

START FINISH

TIME TIME

WATER LEVEL

TIME

DATE

DATE

DATE

REFERENCE

SURFACE CONDITIONS:

SAMPLER TYPE

WATER SAMPLE

WATER SAMPLE

DEPTH OF CASING

SAMPLE NO.

WATER SAMPLE

WATER SAMPLE

WATER SAMPLE

WATER SAMPLE

WATER SAMPLE

WATER SAMPLE

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WATER SAMPLE

WATER SAMPLE

WELL INSTALLATION: Through AUGERS
(1-22-87, 2800)

ACTIVE: Flush in/out + screened:

25.0 ft casing

10.5 ft screen + plug

35.5 ft total

24' above: 2.4'

From: 2.4' - 11.5'

Bottom: 11.5' - 16.5'

Screen: 16.5' - 25.0'

Screen: 25.0' - 32.5'

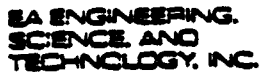
From: 32.5'

- used 110 gal water down hole
to wash sand into place

- completed grouting @ 12:15

- set protective casing (to top of pipe cap)
@ 13:30

- SEE WELL CONSTRUCTION DIAGRAM



LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.5

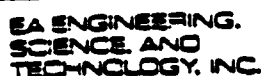
Reference Elevation: _____

Reference Description: Mark on Top of PIC casing

DATE	CLIENT	LOCATION
THU 5/18	USA NAME	CRAP/A26 AA
DRILLING METHOD: H2A 95' 10' 65' 10'	SCALING NO	
CMF 75' all terrain rig	27-02	
	SHEET	
SAMPLING METHOD: 2PT 5' 10' 10' 10'	102	
2' split spm (2' 10' 10' 10') driven by	DRILLING	
10 lb hammer 5' 10' 10' 10'	START	FINISH
WATER LEVEL	TIME	TIME
TIME	09:30 15:55	08:25 17:35
DATE	1-23-87	1-23-87
REFERENCE	5.0F 1.2E	2.5F 2.5E
	1-23-87	1-23-87

SURFACE CONDITIONS: Small covered, open Pacific
approx 100' from rocks

SAMPLE TYPE	TESTS PERFORMED		DEPTH OF CASING	SAMPLE DEPTH	US OWS/B IN SAMPLE	P.L.T. (psi)	DEPTH IN FEET	GRAPHIC LOG	SLURRY CONDITIONS
	WATER	WATER							
									SMALL COVERED, 5m x 2m
									OFFICE 100' from CAGE
SP	15	12	0	1	3	0	0	ML	Dusky brown moist clayey silt. fine fine sand (5V 5/4) (TOP SOIL) ML (mod stiff)
							1		
							2		
							3		
							4		
							5		
SP	18	14	5	2	5	0	6	CL	lt. olive gray moist silt. clay to fine sand (5V 5/4) CL (very stiff)
							7		
							8		
							9		
							10		
SP	18	18	10	3	3	0	11	ML	lt. olive gray moist clayey silt. to fine sand (5V 5/4) ML (medium stiff)
							12		
							13		WHD on cage is ~13.0
							14		
							15	SM	Yellowish brown wet m. & sandy silty silt (10V 5/3) SM (very loose)
SP	18	16	15	4	2	0	16	ML	lt. olive gray wet clayey silt. to fine sand (5V 5/4) ML (very stiff)
							17		(1' sand run up while augering - 20')
							18		
							19		Yellowish brown wet medium fine sand - 1' - (10V 5/4) silty SM
							20	SM	
									C-90



Co-ordinates: _____
 Surface Elevation: _____
 Casing Above Surface: _____
 Reference Elevation: _____
 Reference Description: _____

JOB NO.		CLIENT		LOCATION	
TMA 5153		USATHAWA		LAAP / KEY A	
DRILLING METHOD:				SCORING NO	
				87-02	
				SHEET	
SAMPLING METHOD:				2 of 2-	
				DRILLING	
				START FINISH	
WATER LEVEL				TIME	TIME
TIME					
DATE				DATE	DATE
REFERENCE					

SAMPLING DATA				SURFACE CONDITIONS			
DATE	TIME	DEPTH (m)	DEPTH (ft)	WIND	WAVE	SEA	TEMP
19/10/20	18:20	5.2	17.4				
SPT 19/10/20 5.2				SM Yellowish brown wet medium-fine sand, 1.1% silt (10 YR 4/4) SM (Loose)			
SPT 19/10/20 6.2				SM (4 olive green wet m-f sand, 1.1% silt (5Y 5/3) SM (medium dense)			
SPT 19/10/20 7.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 8.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 9.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 10.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 11.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 12.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 13.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 14.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 15.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 16.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 17.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 18.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 19.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 20.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 21.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 22.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 23.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 24.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 25.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 26.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 27.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 28.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 29.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 30.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 31.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 32.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 33.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 34.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 35.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 36.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 37.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 38.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 39.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 40.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 41.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 42.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 43.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 44.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 45.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 46.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 47.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 48.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 49.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 50.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 51.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 52.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 53.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 54.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 55.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 56.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 57.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 58.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 59.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 60.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 61.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 62.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 63.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 64.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 65.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 66.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 67.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 68.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 69.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 70.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 71.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 72.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20 73.2				SM (continued drilling @ 1230 1-23)			
SPT 19/10/20							



LOG OF SOIL BORING

Cs-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 25

Reference Elevation: _____

Reference Description: Mark 2732 of PVC Cassine

JOB NO.		CLIENT		LOCATION	
TH45188		USATHAMPA		LCAAP 1A25A E	
DRILLING METHOD: H9A. 9422 63"1.0				SCORING NO.	
CME 750 AL-TERMIN 2m				87-03	
				SHEET	
SAMPLING METHOD: 3GT. 15" split spm				102	
(2-940 1/2) driven by a K&B.				DRILLING	
hammer freefalling 30".				START FINISH	
WATER LEVEL 126 7.4 8.62 8.74				TIME TIME	
TIME 1525 0750 0725 0735				1355 1530	
DATE 1-25 626 1-27 1-28				DATE DATE	
REFERENCE SURF SURF 25E 25F				1-25 1-25	

SURFACE CONDITIONS: Snow covered pasture - frozen

SAMPLE TYPE		DEPTH OF CASING		DEPTH OF SAMPLE		P.I.D. (ft)		SURFACE CONDITIONS	
DATE	TIME	DEPTH OF CASING	DEPTH OF SAMPLE	DEPTH OF CASING	DEPTH OF SAMPLE	DEPTH OF CASING	DEPTH OF SAMPLE	DATE	TIME
ST	10/6	0	1/0	2/3	0	0	1	CL	Dark yellowish brown moist clay and silt (10YR 3/2) (soft) (top soil)
							2		
							3		
							4		
							5		
SPT	18/18	5	2/6	4/6	0	5	6	CL	Brownish gray moist silty clay (5YR 3/1) (medium stiff)
							7		
							8		
							9		
							10		
SPT	18/16	10	3/11	3/6	0	10	11	CL	Olive gray moist (massive, rounded) silty clay (5Y 2/2) (mod stiff)
							12		
							13		
							14		
							15		
							16		
SPT	18/18	15	4/16	2/3	0	15	16	CL	Olive gray wet silty clay (5Y 3/1) (soft)
							17		
							18		
							19		
							20		
							21		
							22		
							23		
							24		
							25		
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							60		
							61		

LANC-WESTERN
TOM BUTLER

[illegible]



EA ENGINEERING,
SCIENCE, AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

LOG NO.

CLIENT

LOCATION

THE SIBB

OSAT-HAMA

LCAPAP / AREA E

DRILLING METHOD: HSA

BOREHOLE NO.

87-03

SHEET

2 of 2

SAMPLING METHOD: SPT

DRILLING

START FINISH

TIME TIME

WATER LEVEL

TIME

DATE

DATE DATE

REFERENCE

SURFACE CONDITIONS:

SAMPLER TYPE	DEPTH OF CASING	SAMPLE DEPTH	W. GWS/6 IN. SAMPLE	P.I.D. (ppm)	DEPTH IN FEET	GRAPHIC LOG
SPT 18/18	20	5/24	3/4	0	0	ML
					1	
					2	
					3	
					4	
					5	
SPT 18/18	25	6/26	↓	0	5	SN
					6	
					7	
					8	
					9	
					10	
					11	
					12	
					13	
					14	
					15	
					16	
					17	
					18	
					19	
					20	

Greenish gray wet clayey silt, some moderate (SGY 5/1) yellowish (10YR 5/4) mottling (ML) (medium stiff)

Augered to 25' and sampled
olive brown wet medium to fine sand, trace silt (SY 4/6) (very loose) SN

Bottom of Auger @ 25.0'
Bottom of sample @ 26.5'

WELL INSTALLATION DETAILS:

Start: 1-26-97 1420
Finish: " 1545

Strikeup: 2.5
Grout: Start to 2.5
Bentonite: 2.5 to 7.5
Sand back: 7.5 to 25.0
Screen: 12.5 to 22.5 Bow @ 23.0

Casing: 15.0' (10.0' x 5.0' sections)
Screen: plug: 17.5
2.55'

- installed on an open hole - no casing
after drilling auger

- set protective casing @ 1540



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LOG OF SOIL BORING

Co-ordinates: _____
Surface Elevation: _____
Casing Above Surface: 2.5
Reference Elevation: _____
Reference Description: Mark on top of PC Casing

PROJECT: USA
LOCATION: LCAP/AREA E
DRILLING METHOD: H.S.P. - Hollow Stem Auger
Boring No.: 87-04
Sheet: 1 of 2
SAMPLING METHOD: SPT - Standard Pen. Test
18" Split Sample (2" ID) driven by a
140 lb hammer free-falling 30"
WATER LEVEL: 12.2 | 7.93 | 7.83
TIME: 1010 | 0740 | 0835
DATE: 1-27 | 1-28 | 1-29
REFERENCE: SURE | REF | REF | 12-87 | H2-BT

SURFACE CONDITIONS: Flat arid corrie pasture
adjacent to Ditch "B-1"

SAMPLE TYPE	WATER SAMPLE	WATER ANALYSIS	DEPTH OF CASING	SAMPLE DEPTH	WATER IN SAMPLE	P.I.D. (ppm)	DEPTH (feet)	USING LOG	DESCRIPTION
SPT 18/12	0	15	3	5	8	0	0	CL	Olive black moist silty clay (topsoil) (5x2/1) (stiff)
							1		
							2		
							3		
							4		
							5		
SPT 18/18	5	26	4	4	5	0	6	CL	Olive gray moist silty clay (5x3/1) (medium stiff)
							7		
							8		
							9		
							10		
SPT 18/19	10	31	3	4	6	0	11	CL	Olive gray moist wet silty clay (5x4/1) (med. stiff) some orange mottling
							12		
							13		
							14		
							15		
SPT 18/19	15	4	2	4	4	0	16	CL	Olive green and moderate yellowish brown clay silty (5x4/1) (med. stiff) (10x2.5/4) (wet) CL
							17		
							18		
							19		
							20		
							21		
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							98		
							99		
							100		

GRADUATION CONTINUED (CLAY ending to 2.14 with depth)

ML C-94

BIRMINGHAM LANE - WESTERN TOWN BUTLER

LOW MECHANISMS



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

CB NO.

THA5108

CLIENT

USA THAMA

LOCATION

LSRAP/KRSE

DRILLING METHOD: HSA

BORING NO.

87-04

SAMPLING METHOD: SPT

SHEET

2 of 2

DRILLING

START FINISH

TIME

TIME

WATER LEVEL

TIME

DATE

REFERENCE

DATE

DATE

SAMPLE TYPE	DEPTH (ft)	DEPTH (m)	DIAMETER (in)	DIAMETER (mm)	DEPTH (ft)	DEPTH (m)	DEPTH (ft)	DEPTH (m)
SPT	18	20	5	2	1	0	1	0
SPT	18	23.5	6	3	5	0	5	0
					6		6	
					7		7	
					8		8	
					9		9	
					10		10	
					11		11	
					12		12	
					13		13	
					14		14	
					15		15	
					16		16	
					17		17	
					18		18	
					19		19	
					20		20	

SURFACE CONDITIONS:

ML Olive green wet clayey silt (5.5' to 7.5') (Very Soft)

ML Grayish green wet silt, trace fine sand (5.5' to 7.5') (Stiff)

Augered to 25.0 - Bottom of Hole @ 25.0

Well Installation: Pulled auger - pulled string
down - no caving

Start: 10:20 AM 10/15

Finish: 1:20 PM 11/10

Spillage: 2.5

Grout: Spilled to 2.5

Grout: 2.5 to 7.5

Grout: 7.5 to 25.0

Grout: 12.5 to 22.5

Spill: 2.5

Casing: 15.0' (10.5' section)

Screen: 10.5

Plug

2.5

Set primitive casing @ 11.0

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface: 2.5'

Reference Elevation:

Reference Description: Mark on Top of RC Casing

CO VO.

6-248

LESAFCM

TLA-5, B8

VSAITHANA

LC790 / 624 F

DRILLING METHOD: Hand Drilling

ACRINC 40

at 0.5% I.D. ; CME 750 AM $\frac{1}{1000}$
R₁:-

87-05

SAMPLING METHOD: SPT. Standard Penetration

SECRET

1. cf 2.

Test: 10° split screen (2000 Hz) driven by

ROLLING

14013 hammer face falling 30"

START | FINISH

WATER LEVEL	14.0	9.47	9.31
-------------	------	------	------

TIME	TIME
11:00	11:00
11:15	11:15
11:30	11:30
11:45	11:45
12:00	12:00
12:15	12:15
12:30	12:30
12:45	12:45
13:00	13:00
13:15	13:15
13:30	13:30
13:45	13:45
14:00	14:00
14:15	14:15
14:30	14:30
14:45	14:45
15:00	15:00
15:15	15:15
15:30	15:30
15:45	15:45
16:00	16:00
16:15	16:15
16:30	16:30
16:45	16:45
17:00	17:00
17:15	17:15
17:30	17:30
17:45	17:45
18:00	18:00
18:15	18:15
18:30	18:30
18:45	18:45
19:00	19:00
19:15	19:15
19:30	19:30
19:45	19:45
20:00	20:00
20:15	20:15
20:30	20:30
20:45	20:45
21:00	21:00
21:15	21:15
21:30	21:30
21:45	21:45
22:00	22:00
22:15	22:15
22:30	22:30
22:45	22:45
23:00	23:00
23:15	23:15
23:30	23:30
23:45	23:45
24:00	24:00

TIME	120.5	0750	085
------	-------	------	-----

1315 | 1430

DATE	1-27	1-28	1-29
------	------	------	------

DATE	DATE
------	------

REFERENCE	SURF	REF	REC
-----------	------	-----	-----

1-77-5711-222

3.6.4.2.2. CONCLUSIONS

Flat gravel covered pasture, inside of Ditch B and Ditch B-1 confluence

SAMPLER TYPE				DEPTH OF CASING				DEPTH OF SAMPLE				DIAMETER				SURFACE CONDITIONS			
SAMPLER TYPE				DEPTH OF CASING				DEPTH OF SAMPLE				DIAMETER				SURFACE CONDITIONS			
SPT 18				0				1				ML				Dark yellowish brown moist med. stiff clayey silt (10 YR 5/2) (TOPSOIL) ML			
SPT 18				5				2				CL				Olive black moist stiff silty clay CL (5Y 2/1)			
SPT 18				10				3				ML				Olive gray wet soft clayey silt ML (5Y 5/2) - some orange brown iron concretions			
SPT 18				15				4				ML				Olive gray and Dark yellowish brown clayey silt (10 YR 4/2) - wet med st. G. - some iron concretions (brown portion of sample) ML			
SPT 18				20				5				ML				Trace of iron - found sand on outside of auger from drilling 15-20'			



Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Designation: _____

CA 40

CLIENT

15-00000

THA 51134

USATHCMA

LCAPB 2, 4, 5

MAILING METHOD: HSA

SCREENING NO.

87-05

SAMPLING METHOD: SPT

SUBJECT

2 or 2

DRILLING

START	FINISH
-------	--------

TIME	TIME
------	------

1

DATE	DATE
11/1/54	11/1/54
11/2/54	11/2/54
11/3/54	11/3/54
11/4/54	11/4/54
11/5/54	11/5/54
11/6/54	11/6/54
11/7/54	11/7/54
11/8/54	11/8/54
11/9/54	11/9/54
11/10/54	11/10/54
11/11/54	11/11/54
11/12/54	11/12/54
11/13/54	11/13/54
11/14/54	11/14/54
11/15/54	11/15/54
11/16/54	11/16/54
11/17/54	11/17/54
11/18/54	11/18/54
11/19/54	11/19/54
11/20/54	11/20/54
11/21/54	11/21/54
11/22/54	11/22/54
11/23/54	11/23/54
11/24/54	11/24/54
11/25/54	11/25/54
11/26/54	11/26/54
11/27/54	11/27/54
11/28/54	11/28/54
11/29/54	11/29/54
11/30/54	11/30/54

REFERENCE

[illegible]

SURFACE CONDITIONS:

	/		/	2	
SAT 10	/	20	5	4	0
	/		/	5	

29

ML Medium bluish greenish gray wet silt and clay
(FV G-4 S/1) - some bent material
- medium stiff

SPT	13	23.5	6	3	0
	13	23.5	6	3	
				4	

4

ML Minimum bluish/greenish gray wet clay, silty
(5/2-6 5/1) trace iron sand
- med. sand

Answered to 25" \therefore
Bottom of Hole @ 25.0

WGL INSTALLATIONS: open hole - pulled
JUGS

start 127 1500

Aug. 1-27 1535

Sickys 2.5

Govt: 0+32.5

3rd grade 25 to 7.5

Sound levels: 7.5 to 25.0

Σπ, λη : 12.5622.5

3.0 Nii 23.0

Casing 15.0' (10.0 ± 5.0' size - 0.5)

Score: 10.5

215

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- protective casing installed @ 1935

C-97



Reference Description: MARK ON TOP OF PIC CASE

CONDITIONS: Pasture - in bloom South side
of Ditch "B"

C-100



LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.	CLIENT	LOCATION
THA 5138	USA THAMA	LCARR/RRD C
DRILLING METHOD: HSA		BORING NO.
		87-07
SAMPLING METHOD: SPT		SHEET
		2 of 2
WATER LEVEL		DRILLING
TIME		START
DATE		FINISH
REFERENCE		TIME
		DATE

SAMPLE TYPE	DATE	DEPTH (ft)	DEPTH (m)	P.I.D. (ppm)	GRAPHIC LOG	SURFACE CONDITIONS
SPT	18/19	20	5.1	0	ML	Vellawish brown (with some olive green) silt, trace fine sand (ML) - very soft, wet
SPT	18/19	23.5	6.2	0	ML	Medium bluish/greenish gray and moderate brown (SPT 3/4) - wet silt + very soft (ML) Augered to 25' Bottom of Hole @ 25.0'
						WELL INSTALLATION: Pulled Auger + placed well in open hole
						Start: 1640 1-28
						End: 1710 1-28
						Stickup: 2.5'
						Grout: 0 to 2.5
						Grout: 2.5 to 7.5
						Grout: 7.5 to 22.5
						Grout: 22.5 to 23.0
						- Placed protective casing @ 1710
						- used 20 gal H ₂ O to wash silt down hole



**SEA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.**

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.5

Reference Elevation: _____

Reference Description: MEK in Top of Air Casing

JOB NO.		CLIENT		LOCALITY	
TUN 5130		USATHAMA		LCAP AREA E	
DRILLING METHOD: HSA - Hollow Stem				BORING NO.	
Length: 9' 10", 6' 10" (CMG 75)				87-08	
Soil Terrain: drill ris				SHEET	
SAMPLING METHOD: SPT - Standard Penetration				1 or 2	
25' + 19" split spool (2" 10" 1.2) driven				DRILLING	
Dwg. 140 16th Street - 3rd - Alling 30"				START & FINISH	
WATER LEVEL		4.5	7.37	7.57	7.73
TIME		12:00	0835	0745	0800
DATE		1-29	2-3	2-4	2-5
REFERENCE		Surf REF	REF	REF	REF
		1-29-57	1-29-57	1-29-57	1-29-57

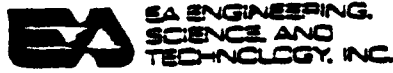
SURFACE CONDITIONS:

Open pasture - not irrigated

[illegible]

C-102

MW18-6



LOG OF SOIL BORING

Co-ordinates: _____
 Surface Elevation: _____
 Casing Above Surface: _____
 Reference Elevation: _____
 Reference Description: _____

JOB NO.	CLIENT	LOCATION
TH-5139	USAT/Amc	Warp/area 6
DRILLING METHOD: HSA		BORING NO.
		87-08
SAMPLING METHOD: SPT		SHEET
		202
		DRILLING
		START FINISH
WATER LEVEL		TIME TIME
TIME		DATE DATE
DATE		DATE DATE
REFERENCE		

SAMPLE TYPE	DEPTH OF CASING	DEPTH OF SAMPLE	R.D. (ppm)	DEPTH	DESCRIPTION	SURFACE CONDITIONS
SPT	18	20	5/21	17	SM	Grainy dirt and red brown alternating horizontal (10 V45) (5 V4 0/4) Monium to fine sand and silt - dirt very dense SM
SPT	18	23.5	6/23	22	SW	LT Olive green wet Very loose med-fine sand, to silt (5 V4 5/20) SW
				2		Ground to 25' - Sand ran up in auger pulled auger up bottom of to 20' re-drill and re-drilled to 25, used HSA 2350 15 gal 1000 rpm auger. Sand ran up past 20' - washed out with second set of rods down hole - lost more than 30 gal 1000 rpm hole - worked.
				30		Well Installation - installed well through auger Start: 1335 - hole full of water - no need and: 1440 to wash sand down with more water
				1		Stickup: 2.5
				2		Arise: 0-2.5
				3		Sanitise: 2.5-7.5
				4		Screen: 7.5-25.0
				5		Screen: 12.5-22.5
				6		Grain of soil: 22.5
				7		Screen size: 10.5
				8		Screen: 15.0 (10.0 - 5.0 section)
				9		22.5
				10		- Inactive rising spt @ 1440

SURFACE CONDITIONS: Cleared edge of dirt road was adjacent to woods on an incline to the north.

DK. yellowish brown moist clayey silt (ML) (SY 6/2) - med. stiff

Lt. olive gray wet stiff silty clay (CL) (SY 6/1) (some small orange iron staining) (Spoon wet @ 5')

Easy augering from 0' + down to 10' saturated clay cutting coming out of hole. Red wet at 9' after augering to 10'.

Olive gray wet stiff silty clay with orange to dusky brown (SY 2/2) iron staining (CL)

Drilling resistance machine \approx 5' - 11' down to 15' indicates of variable layer cake satig.

Lt olive gray and yellowish orange (iron staining) silty clay (SY 6/1) (10YS 5/2) ML - wet medium stiff

Relatively softer materials encountered during drilling \approx 2'.

C-104



**SEA ENGINEERING,
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LOG OF SOIL BORING

Co-ordinators: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

100

CLINT

Section

TUESDAY

USATLANTA

КСОДР/сч 2

TRAINING METHOD: HSA

SCRAM VQ

87-09

Budget

2. 2

SAMPLING METHOD: SPT

CALLING

START

PLAN

WATER LEVEL

706

7000

7.4.8

3A FK

CARE

DATE

REFERENCE

SLAPACI CONDITIONS:

SAMPLE 11 TYPE	DATE 11-11-68 TIME 11:11 BY 1111	DESCRIPTION CASING	SAMPLE 12 DATE 11-11-68 TIME 11:11 BY 1111	DESCRIPTION CASING	SAMPLE 13 DATE 11-11-68 TIME 11:11 BY 1111	DESCRIPTION CASING	SAMPLE 14 DATE 11-11-68 TIME 11:11 BY 1111	DESCRIPTION CASING
-------------------	--	-----------------------	---	-----------------------	---	-----------------------	---	-----------------------

				5	35	20	ML
SPT 18	18	20	5	6		1	
				7		2	
						3	
						4	ML
SPT 18	18	23.5	6	5	46	5	
				10		6	
						7	
						8	
						9	
						30	
						1	
						2	
						3	
						4	
						5	
						6	
						7	
						8	
						9	
						40	

Moderate yellowish brown w/ stiff clayey silt
(10 YR 5/4) ML

(1 ppm in LNU registered in auger)

Moderate yellowish brown w/ very stiff clayey
silt ML

Augered to 25' B.O.H @ 25.0'

(2 ppm in LNU registered in auger)

WELL INSTALLATION - Pulled augers
15-20 in hole (LNU) - broaching
in OK, suited up - definite solvent
odor. Continued positive ridging cutting
Screen: 1150 in SS gal frame provided top
End: 1200 0 in.

End up 2.5
Screen: 1-2.5
Bottom: 2.5-7.5
Sand gate: 7.5-25.0'
Screen: 12.5-22.5
B.O.H @ 23.0'

Riser 150 (100-5.0 lengths)
Screen + 115
Plus 25.5

10-20 ppm in well at completion
Set corrective casing @ 1391

C-105

C-105



LOG OF SOIL BORING

Co-ordinates: _____

 Surface Elevation: _____
 Casing Above Surface: -2.5'
 Reference Elevation: _____
 Reference Description: Mark on Top of PVC Casing

JOB NO.	CUSTOMER	LOCATION
THA 5139	USATHAMA	LCAMP / AREA C
DRILLING METHOD: HCB - Yellow Stem Auger		BORING NO.
9 1/2" x 2 5/8" I.D. : CMG TSD Aug		87-11
TIGERLAND DRILL RIG		SHEET
SAMPLING METHOD: SPT - Standard Penetration		1 or 2
Test: 18" split Spun (23" I.D. 18" I.D.)		DRILLING
WATER DEPTH: 2 RODS Hammer Free-falling 30"		START
WATER LEVEL		FINISH
TIME	13.1	14.78
15.66	15.50	TIME
0710	1155	0150
0830	1605	0945
DATE	2-5	2-5
2-6	7-7	DATE
REFERENCE	SURF	REF
REF	REF	REF
2-5-57	2-5-57	2-5-57

SAMPLE TYPE	DEPTH OF CASING	DEPTH OF CORE	P.I.D.	GRAPHIC LOG	REMARKS
			(ppm)		
SPT 18/0	0	7	0	CL	Dusky yellowish brown moist stiff clay + silt (10 yr 2 1/2) CL
SPT 18/5	5	7	0	CL	Dusky well brown moist stiff clay and silt (10 yr 2 1/2) CL
SPT 18/10	10	9	0	ML	Lt olive gray and yellowish orange moist very stiff clayey silt ML (5X G/L) (10 yr 5/6) - Roll in stirred setting easier @ 12-13' and down - Plug up - after curing to 15' 7' open wet acid
SPT 18/15	15	15	0	SW SP	Lt. yellowish brown wet medium-fine sand, & silt (10 yr 6/2) - medium dense SW

Tom Butler

ALL OTHERS
EXCEPTED



Co-ordinates: _____

 Surface Elevation: _____
 Casing Above Surface: _____
 Reference Elevation: _____
 Reference Description: _____

 $z \approx z$

1

REFERENCE

247



**EA ENGINEERING.
SCIENCE AND
TECHNOLOGY, INC.**

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.7'

Reference Elevation: _____

Reference Description: Mark on Top of PVC Casing

JOB NO.		CLIENT		LOCATION	
TIN 5189		USATUAMA		LEAP / 00.9A C	
DRILLING METHOD: HSA - Hollow Stem Auger				BORING NO.	
G ₁ 0.2 G ₂ 1.2 CMC 730 ALL				87-12	
Iron Drilling rig				SHEET	
SAMPLING METHOD: SPT - Standard Penetration				1 or 2	
Test 13" split spore (2" x 2, 18" 1.0) driven by				DRILLING	
a 140 lb hammer free fall 30"				START FINISH	
WATER LEVEL		15.2	16.82	16.81	
TIME		0735	1710	1730	
DATE		2-6	2-7	2-8	
REFERENCE		SURF	250	REE	
				TIME	TIME
				1640	0500
				DATE	DATE
				2-587	6-2

SURFACE CONDITIONS: *Find out on ground film*

SAMPLER TYPE	WATER SAMPLED	DEPTH IN CASING	SAMPLE DEPTH	US OWS/BH SAMPLER	P.L.D. (ppm)	DEPTH IN CASE	GRAPHIC LOG	SURFACE CONDITIONS
/	/	/	/	2		0	CL	Dusty yellowish brown moist very fine clay + silt (CL)
SPT 18/7	0	1	13	10	0	1		
/	/	/	/			2		
/	/	/	/			3		
/	/	/	/			4		
/	/	/	/	3		5		
SPT 18/10	5	2	5	7	0	6	CL	Clay black moist diff silty clay (CL) (SV 2/1)
/	/	/	/			7		
/	/	/	/			8		
/	/	/	/			9		
/	/	/	/	6		10		
SPT 18/10	10	3	11	10	0	1	SM	Light gray moist fine sand some silt (SM) - medium coarse
/	/	/	/			2		Auger plug wet after drilling → 15'
/	/	/	/			3		
/	/	/	/			4		
/	/	/	/	9		5		
SPT 18/19	15	4	11	16	0	6	SM	Yellowish brown med. - medium-fine sand some silt (SM) - medium coarse
/	/	/	/			7		
/	/	/	/			8		
/	/	/	/			9		No return
/	/	/	/			10		
/	/	/	/			11		
/	/	/	/			12	CL	Drill on to 20 and sampled until about 25 resumed drilling down 25-37"

MW7-8



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO. THA 5138	CLIENT USA THAMA	LOCATION LORRA/HSIC
DRILLING METHOD: HSA		BORING NO. 87-12
SAMPLING METHOD: SPT		SHEET 2 of 2
WATER LEVEL 16.82		DRILLING
TIME 1710	DATE	START TIME
DATE	DATE	FINISH TIME
REFERENCE		

SAMPLE TYPE	WATER SAMPLE	DEPTH OF CASING	SAMPLE NO.	WATER IN SAMPLE	PID (ppm)	DEPTH (FEET)	CHARTING LOG	SURFACE CONDITIONS
SPT 18	18	20	5	21	3	0	CL	Yellowish brown wet soft clayey silt (CL) (10 YR 4/2)
						1	ML	Yellowish brown wet silt, some fine sand (ML) (10 YR 4/2)
						2		No run-up - loaded augers with 20 gals. H ₂ O removed
						3		
						4		
						5		
SPT 18	18	25	6	5	10	0	SM	Yellowish brown wet m-f sand, trace silt (SM) (10 YR 4/4) - medium dense
						7		No run-up
						8		
SPT 18	18	28.5	7	9	12	0	SM	Dark yellowish brown wet m-f sand, trace silt (SM) (10 YR 4/2) - med. dense
						10		Continued to 30'
						30		Bottom 1/2 hole @ 30.0'
						1		WELL INSTALLATION: Through fingers
						2		Start 1915 2-3-87
						3		End 1110 "
						4		Auger: 2.7
						5		Grout: 0-3.5 11.50m 20 gal
						6		Grout: 3.5 to 8.5 11.5 to wash
						7		Grout: 8.5 to 30' sand down
						8		Grout: 17.3 to 27.5'
						9		Grout: 27.8
						10		Grout: 27.8 (2x 10.0')
						11		Grout: 12.5
						12		Grout: 30.0 in-d
						13		Spt grt. casing @ 1110





Cg-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.6

Reference Elevation: _____

Reference Description: Mark is from DVC

ICE NO.		CLIENT		LOCATION	
THA 5182		USA THAMA		LCARP	
DRILLING METHOD: Hollow Stem Auger				BORING NO.	
1 MC 55 RIG, 12" O.D., 4.5" I.D.				86-01	
HSA				SHEET	
SAMPLING METHOD: STANDARD PENETRATION				1 of 2	
TESTS (SPT) - 18" Driven Split				CORRECTION	
SP-01 - 2" O.D. - 140 lb hammer falling 30"				START	
WATER LEVEL				FINISH	
22.30 20.49				TIME	
TIME				TIME	
0805 1200				1040 1900	
DATE				DATE	
5-7-86 5-2-86				DATE	
REFERENCE				DATE	
RSE RSE				5-6-86 5-6-86	

SURFACE CONDITIONS: Grassier hill top 2 to 4 ft high

SAMPLE TYPE	DEPTH FEET	WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX PPM	UNIFORMITY COEFFICIENT	GRADING	REMARKS
	0						Grassier Hill Top ~ top of hill
SPT	1.5	0	1.0	2	0	CL	Moist medium silt with clay - CL Yellowish brown 10 YR 2/6 (GSA)
	2						
	3						DIFFICULT AUGERING - INTO WEATHERED SURFACE
	4						
SPT	1.5	4.3	2.5	16	0	ML	Moist hard clay silt + trace fine sand ML (Weathered shale - horizontal orientation) Light olive brown - 5Y 5/6
	5						
	6						
	7						
	8						
	9						
SPT	1.5	9.3	3.5	32	0	ML	Moist hard clayey silt + trace fine sand ML (Weathered shale - horizontal orientation) Light olive yellow gray 5Y 5/3
	10						
	11						
	12						
	13						
	14						12.0-12.3 - easier augering
SPT	1.4	14.3	4.5	30	0	ML	Moist hard clayey silt + trace fine sand ML (Weathered shale - horizontal orientation) Light olive yellow gray 5Y 5/3
	15						
	16						
	17						
	18						
	19						
SPT	0.3	19.3	5.5	24	0	CL	Moist hard silty clay - massive weathered shale Medium gray - NS' CL
	20						



Reference Designation: _____

JOB NO.		CLIENT		LOCATION	
THASISS		USATHAMA		LEAP/AREA C	
DRILLING METHOD: HSA				BORING NO.	
				87-13	
				SHEET	
SAMPLING METHOD: SPT				202	
				DRILLING	
				START FINISH	
WATER LEVEL				TIME	TIME
TIME					
DATE				DATE	DATE
REFERENCE					

SURFACE CONDITIONS:

SAMPLE TYPE	DATE	DEPTH OF CASING	DEPTH OF SAMPLE	WATER IN SAMPLE (ppm)	DEPTH	GRATING	SURFACE CONDITIONS
					20	ML	Coarse 20 gal H ₂ O in auger
					1		
					2		
					3		
SPT 18	18	23.5	6	4	4	ML	Yellowish brown silt, little sand (10/10/12)
				8	5		olive gray clayey silt (5/5/10) - 10/10/12
					6		Loaded 20 gal H ₂ O in auger
					7		
					8		
SPT 19	19	28.5	7	2	9	SM	DK yellowish brown fine sand, little silt (SM) (10/10/12) - wet, loose
				3	10		Augered to 30'
				2	30		
					1		<u>WELL INSTALLATION - Through Auger</u>
					2		Start: 0005 2-7-97
					3		End: 1050 2-7-97
					4		Stirrup: 2.5'
					5		Gravel: 0-2.5'
					6		Bottom: 3.5-8.5'
					7		Sand (ch): 8.5-30'
					8		Screen: 17.5-27.5'
					9		B. 2. well: 28.0'
					10		
					11		used 40 gal H ₂ O to wash sand down hole
					12		set port casing @ 12.5'
					13		
					14		
					15		
					16		
					17		
					18		
					19		
					20		

Highly Confidential

... only

C-117

MW7-10



**EA ENGINEERING.
SCIENCE AND
TECHNOLOGY, INC.**

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Designation: _____

THAS/B4

CLIENT
USATAMA

LOCATION
LCAPF/ARSA C

TRAINING METHOD: HSA

SPRING 40

87-14

3448

202

SAMPLING METHOD: SPT

2014-2015

START	FINISH
-------	--------

TIME	TIME
------	------

WATER LEVEL

34

341

DATE	DATE
------	------

REFERENCE

SURFACE CONDITIONS:

[illegible]

Dark reddish brown wet silt + silt, 2.5' clay zone
(10% ch) ML p 21'

Medium grayish / bluish gray wet soft clayey silt (M)
(5 GY 5/1)

Yellowish brown wet fine sand, some silt (sm
(10 x 2 3/4) - loose

Yellowish brown wet med. dense matrix to fine sand.
(ID YG 4/a) little silt +
Augered to 30' @ 1500
Bottom of H₂O @ 30.0'

White IN STR. LAYERS: 2-3 - 3' sand run up in
 casing - washed out with 20 and 40's but run by's
 - installed well through after minutes
 Sinter: 2945, 2-8-37 - used within 20 and
 End: 1115, 2-8-37 - to this down water
 in hole.

Stack up: 2.3	
Root: 0 to 2.5	2.564 229 122721
Partials: 2.5 to 7.5	30000 195
Impulse: 7.5 to 30.0	1ms
Sensor: 17.2 to 27.2	50.5
4.9.11.11: 20.7	

Set 2nd two rising @ 1115

C-119

MW 5-5



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.5

Reference Elevation: _____

Reference Description: Mark on Top of VC Casing

JOB NO.	CLIENT	LOCATION
TLA 5738	1/2 Atlanta	LEAP/AREA B
DRILLING METHOD: <u>HSA - 4 1/2" dia. auger</u>		BORING NO.
<u>94.0.0, 43.1.0: CME 790 All-</u>		<u>87-15</u>
<u>terrain drill rig</u>		SHEET
SAMPLING METHOD: <u>SPT - Standard Penetration</u>		<u>1 of 2</u>
Test 18" split spm (2' x 2' x 10) driven by		DRILLING
<u>2 1/4 lb. hammer free falling 30"</u>		START TIME
WATER LEVEL	<u>9.5</u>	<u>10.55</u>
TIME	<u>0921</u>	<u>1665</u>
DATE	<u>2-9</u>	<u>2-10</u>
REFERENCE	<u>SURF</u>	<u>REF</u>
	<u>2-5-51</u>	<u>2-8-51</u>

1000 LBS. CEMENT - 1000 LBS. CEMENT
 1000 LBS. CEMENT - 1000 LBS. CEMENT

1000 LBS. CEMENT - 1000 LBS. CEMENT
 1000 LBS. CEMENT - 1000 LBS. CEMENT

SAMPLE TYPE	DEPTH OF CASING	DEPTH OF SAMPLE	RI.D. (ppm)	DEPTH (ft)	GRADING	DESCRIPTION
SPT 18/7	0	1/0	3	0	ML	Yellowish brown moist stiff clayey silt (ML) (10 yr 3/2)
				1		
				2		
				3		
				4		
				5		
SPT 18/10	5	2/6	3	0	ML	Blackish brown moist medium stiff clayey silt (ML) (5 yr 3/1)
				6		
				7		
				8		
				9		
				10		
SPT 18/10	10	3/11	2	0	ML	Dr. yellowish brown (same med. dk. gray) clayey silt (ML) (10 yr 6/2) - moist soft
				1		
				2		
				3		
				4		
				5		
SPT 18/15	4	1/16	2	0	ML	Dr. yellowish brown moist very soft clayey silt (ML) (10 yr 4/3)
				6		
				7		
				8		
				9		
				10		



LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: 2.5'

Reference Elevation: _____

Reference Description: Made in T.S. 3-2 D/C 1st

COUNT

26.55

TK45180

USATHCm

62440/10500

DRILLING METHOD: HSA - 15/150 Slim Run

SCREENING VO

GT 0.0 6 3/8" I.D. CNE 750 211-

87-16

termina de illa

SECRET

SAMPLING METHOD: *See* *Sampling*

182

$$= 96:180 \text{ mit } 5000 (2000) \text{ mit } 10000$$

3 MILLING

10-31-79

DATE: 07/11/2014	TIME: 08:00	STATUS: OK
------------------	-------------	------------

141	142	143	144
-----	-----	-----	-----

TIME	TIME
------	------

WATER LEVEL	24.2	15.86	15.96
TIME	1:55	1:55	1:55

1303 1405

TIME	1433	1615	1450
------	------	------	------

500 1403

DATE	12-9	12-9	12-10
------	------	------	-------

DATE 3-2-75

REFERENCE SURF REF REF

6-757 24-5

SURFACE CONDITIONS: *Gressed lawn near building, 10A*

SAMPLE TYPE	DATE SUBMITTED	DEPT. CASINO	ANALYST NAME	IN CHARGE SAMPLE	P.I.D.	LABORATORY NO.	GRAPHIC LOG
					(25)		

[illegible]

MW5-6



EA ENGINEERING,
SCIENCE AND
TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.	CLIENT	LOCATION
THAS188	USATHAMP	LCAAP/AREA B
DRILLING METHOD: HSA		BORING NO.
		87-16
SAMPLING METHOD: SPT		SHEET
		2 of 2
		DRILLING
		START
		FINISH
WATER LEVEL		TIME
TIME		TIME
DATE		DATE
REFERENCE		DATE

SAMPLER TYPE	DEPTH OF CASING	DEPTH OF SAMPLER	DEPTH OF SAMPLER	PLD. (ppm)	DEPTH (feet)	GRAPHIC LOG	SURFACE CONDITIONS:
SPT	18	20	5	2	0	20	Yellowish brown wet soft clayey silt ML (10 VR 4/4)
	18	21	2	2		1	
						2	
						3	
						4	
						5	
SPT	18	25	6	4	0	6	Yellowish brown wet med. stiff silt and clay, some (10 VR 5/3) fine gravel (angular shale frags), trace coarse to fine sand (ML)
	18	26	3	3		7	
						8	
SPT	18	28	5	7	0	9	Yellowish brown wet med. stiff silt and clay (10 VR 5/3) (ML)
	18	29	3	3		10	Accessed to 32'
						11	Bottom of hole @ 32.0'
						12	WELL INSTALLATION Pulley system, installed well on 4" diam. cable
						13	Start: 1645, 2-9-87
						14	End: 1525, 2-9-87
						15	Stickup: 2.5' Run 23.0 (2x10.0')
						16	Grout: 0-4.0' Screen = 10.5'
						17	Backfill: 4.0-9.0' using 3/4" grad
						18	Sand pack: 9.0-30.0'
						19	Screen: 17.5-27.5'
						20	O.D. well: 28.0'
						21	Set portable casing @ 1630
						22	
						23	
						24	
						25	
						26	
						27	
						28	
						29	
						30	

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

100%

CLIENT

LOCATION

DRILLING METHOD:

BORING NO.

87-17

SWEET

202

SAMPLING METHOD

CALLING

START

P 41924

WATER LEVEL

TIME

FME

TIME

CATE

GATE

2428

REFERENCE

SURFACE CONDITIONS:

Sandier clay SG 2.57R 6/4
Duro 14 colors

Spon slide in:
10 feet 17 water column in SS 10%
Wet SM 6254R 5/2

12:10 Left runway sand & in hole
large station leads in water
with creek out hole

12:30 Paul with wife
to begin working on garden
1:40 call me. - 1:40

13.25 mixed flake 100 gms 100 gal.

1/24 - 1/25 = 1/25

Well installed by 1920 and 1540
bottom of hole at 30'

Ship 2.5'
Swd 30 to 100
Penetration to 5
(cont)

USATHAMA

LOG OF SOIL BORING

Co-ordinates: _____
 Surface Elevation: _____
 Casing Above Surface: _____
 Reference Elevation: _____
 Reference Description: _____

LOG NO. LCAP	CLIENT Bulky 6	LOCATION Bulky 6
DRILLING METHOD: HSA 7 1/2" x 6 1/4" ID		BORING NO. 87-18
CME 750 All Terrain Rig		SHEET 1 of 2
SAMPLING METHOD: SP 18" Split Sp		DRILLING START FINISH
(2.0' OD, 1 1/4" ID) driven by		TIME 7:35 11:55
14016 Hammer Penetration		DATE 2/11/87
WATER LEVEL 15' 18.5'	TIME 10:05 7:35	DATE 2/11/87
DATE 2/11	DATE 2/12	DATE 2/11/87
REFERENCE Ent OK	REFERENCE OK	DATE 2/11/87

SAMPLE TYPE	WATER CONTENT	DEPT OF CASING	SAMPLE DEPT	BLOWS/S IN SAMPLER	INCHES IN FEET	GRAPHIC LOG	SURFACE CONDITIONS
SS 1/8				2	0		Grassy area near well Bulky 6
					1		
					2		
					3		
					4		
SS 1/8			1/5	3	5		reddish brown clay - silt mix
				7	6		fine roots organic
					7		CL 2.5 YR 5/2
					8		dark
					9		good bit of clay soil no from the surface
					10		material - orange
SS 1/8			2/10	5	10		dark
				9	11		CL 2.5 YR 6/4 SM
					12		
					13		
					14		
SS 1/8			3/15	3	15		dark silty a little sand
					16		gray CL 2.5 YR 5/2
					17		begin to sub into fine
					18		
					19		
					20		

MW12-3

USATHAMA

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.

LCAPP

CLIENT

LOCATION

Bathy 6

DRILLING METHOD:

BORING NO.

87-18

SAMPLING METHOD:

SHEET

2 of 2

DRILLING

WATER LEVEL

START

FINISH

TIME

TIME

TIME

DATE

DATE

DATE

REFERENCE

SAMPLE TYPE	WATER DEPTH	DEPTH OF CASING	SAMPLE NO.	WATER IN SAMPLE	DEPTH IN FEET	GRAPHIC LOG
SS	18	4	5	0	20	
			8		1	
			10		2	
					3	
					4	
SS	18	5	6	0	25	
			11		6	
			15		7	
					8	
					9	
SS	18	6	5	0	30	
			10		1	
			16		2	
					3	
					4	
					5	
					6	
					7	
					8	
					9	
					10	

SURFACE CONDITIONS:

Wet sand little silt
red clay
2.5Y 5/2 SM

Wet sand red clay
2.5Y 5/2 SM

11:00 at pump sand after taking 5' sample
change to red clay at 10' level and 11:00
11:00 start drilling back up
Water level at 2.5Y 5/2 SM

Wet sand red clay
2.5Y 5/2 SM

Wet sand red clay
3:10
10:10

MW12-1

USATHAMA

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

JOB NO.
LCAP

CLIENT

LOCATION

DRILLING METHOD:

Boring No.

87-19

SHEET

2 of 2

SAMPLING METHOD:

DRILLING

START FINISH

TIME TIME

WATER LEVEL

TIME

DATE

REFERENCE

DATE DATE

DRILLING LOGS

SAMPLER TYPE	WATER LEVEL	DEPTH OF CASING	SAMPLE DEPTH	BLOWS/S IN SAMPLER	DEPTH (IN FEET)	GRAPHIC LOG	SURFACE CONDITIONS
S	18 1/2	4	5	0	20		Wet sand reddish brown 2.5 x 5/2 SM
			6		1		
			7		2		
					3		
					4		
JS	18 1/2	5	5	0	25		Wet sand reddish brown 2.5 x 5/2 SM stop
			6		6		Heavy sand grain 16 SS
			11		7		Start time 08:05 2/12
					8		Trig is just over done without the plug
					9		Arrived 08:30. Plug worked to 27'
					10		Before we had at
					11		08:15 water on in 5 minutes
					12		10 gal lost
					13		8:35 finished
SS	18 1/2	6	1	0	30		Wet sand reddish brown
			9		1		
			14		2		
					3		
					4		
					5		
					6		
					7		
					8		
					9		
					10		
					11		
					12		
					13		
					14		
					15		
					16		
					17		
					18		
					19		
					20		

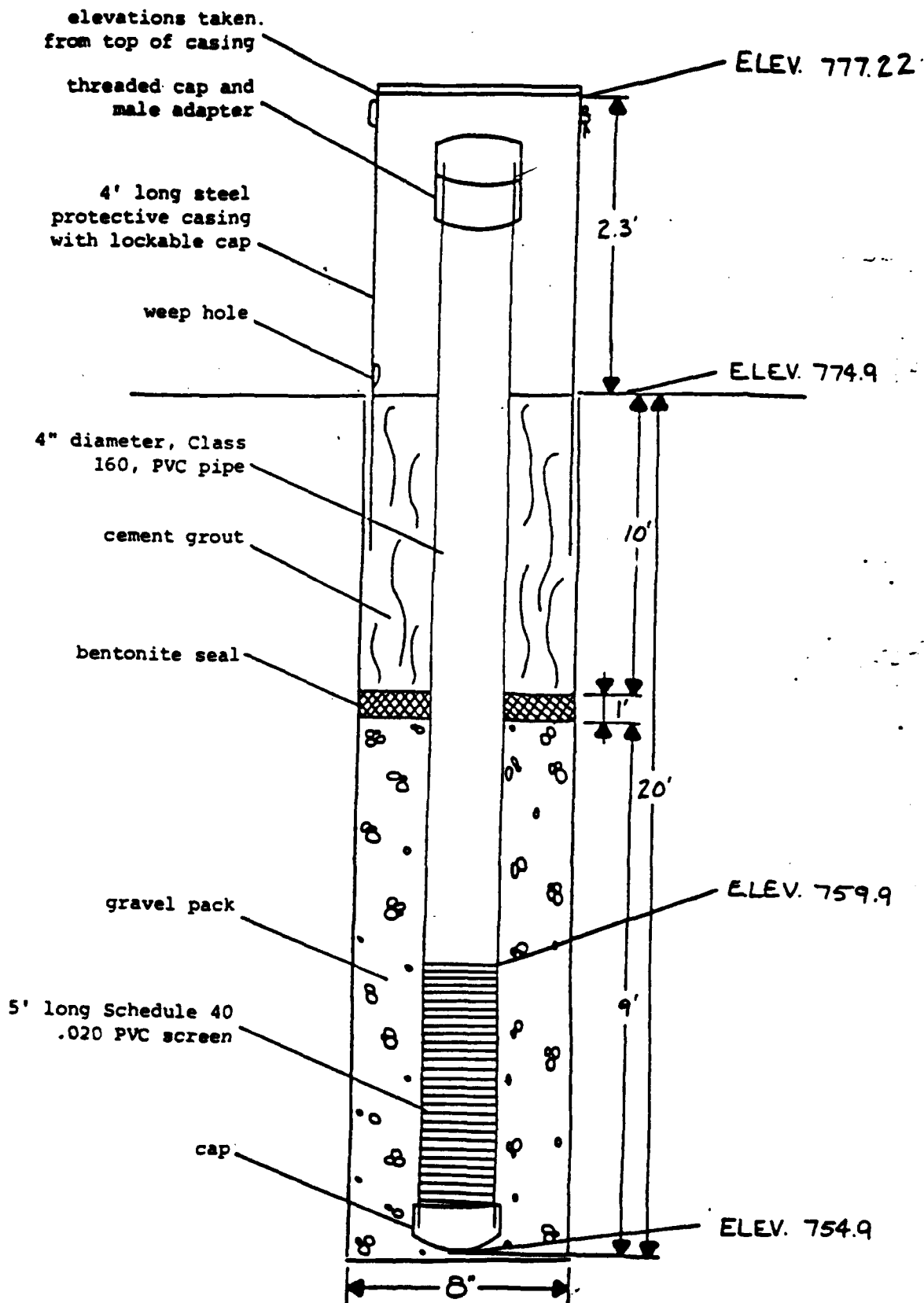
no
page C-130

PSI-

no
bracket
here -

these pages be sure this
are already double sided starts on
right

CONSTRUCTION OF WELL



MW 1-1

TEST BORING LOG

Lake City AAP

Boring No. MW 1-1 Sheet 1 of 1

Surface Elevation 774.9 Offset

Date Started 8/11/81 Completed 8/11/81

Driller **T. Butler** Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**MARKS: (Casing, Water Loss, Etc.)**

STATIC Water Level

Time

Date _____

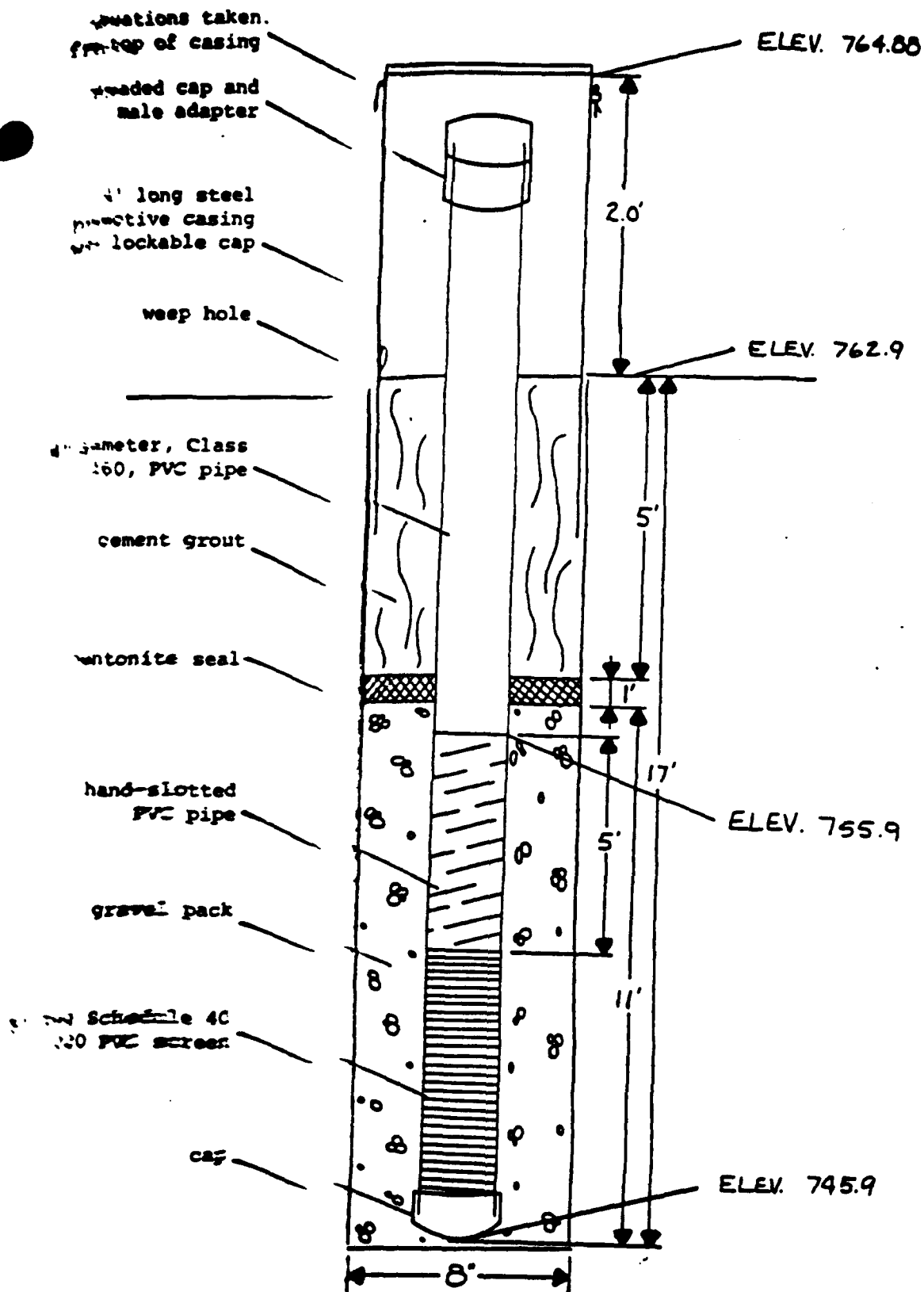
4 Pumped 1-1/2 hour - 1/2 GPM

1.7

9/11/81 (Completion)

Wyne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 1-2

TEST BORING LOG

Project Lake City AAP

Boring No. MW 1-2 Sheet 1 of 1

Address _____

Surface Elevation 762.9 Offset _____

City & State Independence, Missouri

Date Started 7/29/81 Completed 7/29/81

Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	5.5'	WB				Dark gray silty clay, med. to stiff
5.5'	10.0'	WB				Dark gray silty clay, med.
10.0'	11.5'	SS1				Dark gray silty clay, med. to stiff
11.5'	17.0'	WB				Weathered sandy shale, med.
17.0'	19.0'	WB				Maroon shale, stiff to very stiff
19.0'	22.5'	WB				Light tan & light gray shale, stiff to very stiff
22.5'	26.0'	WB				Light gray shale, med. to stiff
26.0'	29.5'	WB				Same
29.5'	35.0'	WB				Same
1'	37.5'	WB				Same
5'	40.0'	WB				Maroon & light gray shale, med. to sti
0'	Total depth					

RKS: (Casing, Water Loss, Etc.)

umped 1-1/2 hour - 1 GPM

Static
Water Level

1.6

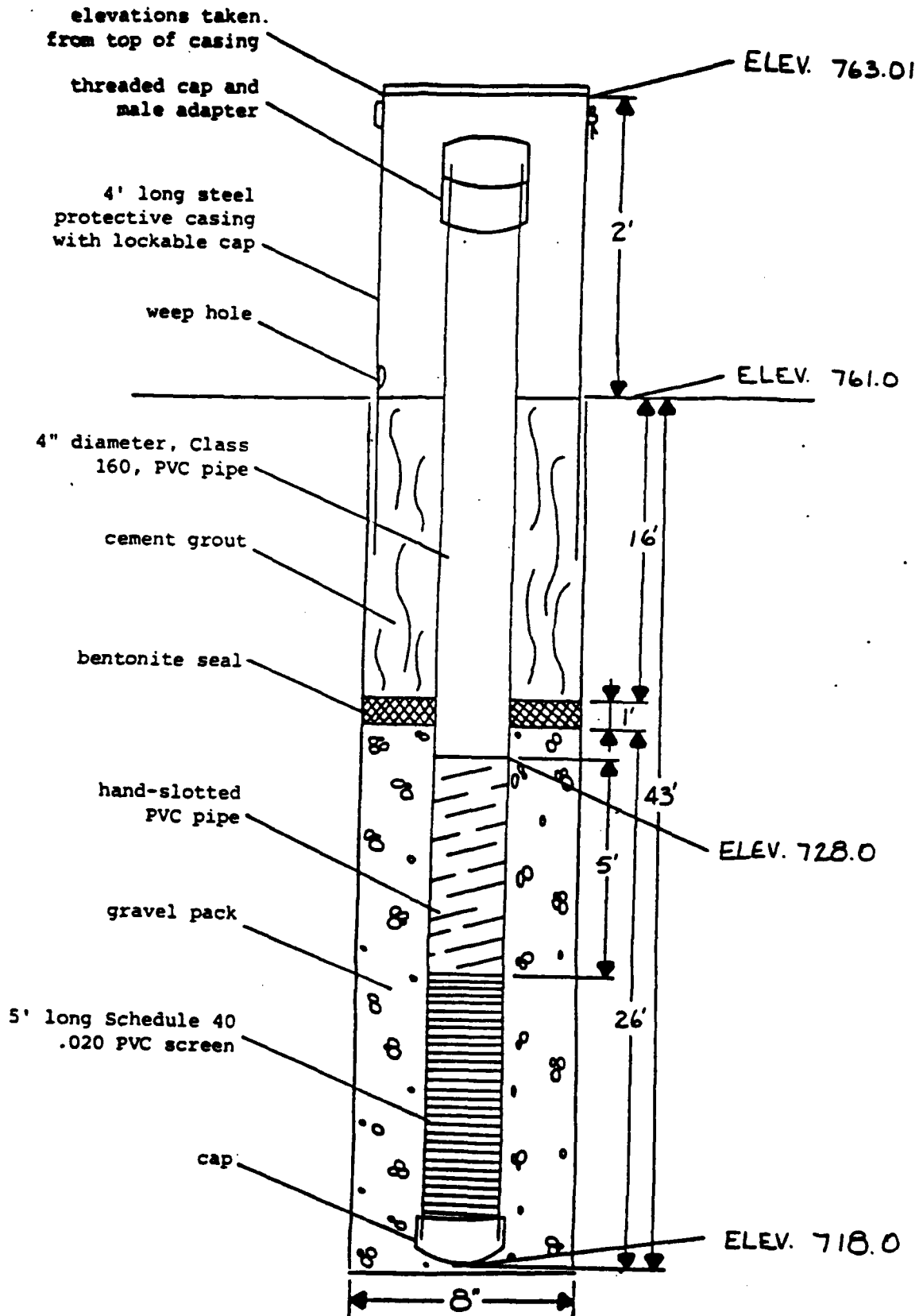
Time

Date

9/11/81 (Completion)

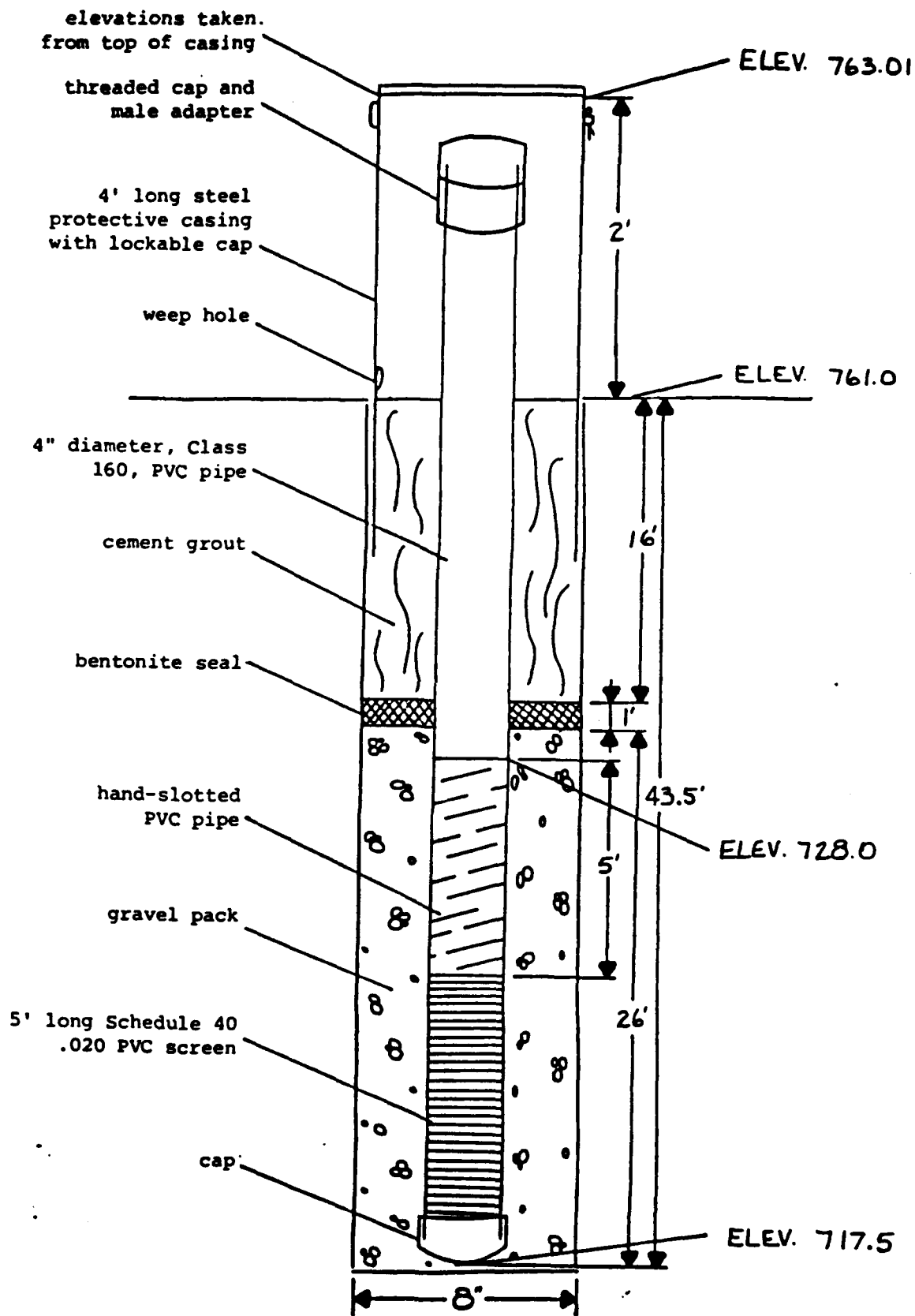
ne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 1-3

CONSTRUCTION OF WELL



MW 1-3

TEST BORING LOG

PROJECT Lake City AAP

Boring No. MW 1-3 Sheet 1 of 1

Surface Elevation 761.0 Offset _____

Date Started 7/30/81 Completed 7/30/81

State Independence, Missouri

Driller T. Butler Rig _____

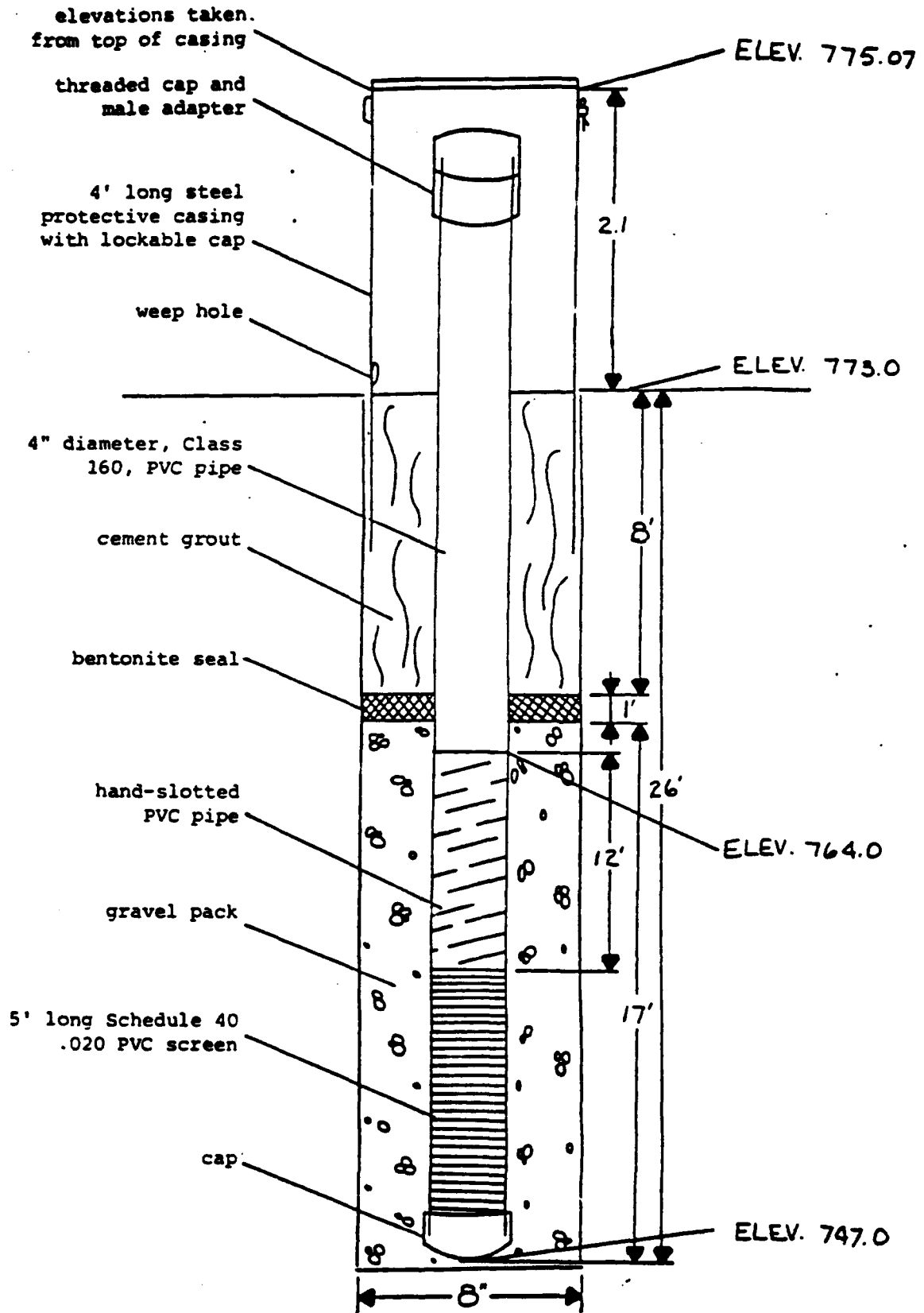
Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH	FROM	TO	METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
				POCKET PENETRO-METER	NO OF BLOWS		
0.0'	1.0'	1.0'	WB				Topsoil
1.5'	2.0'	2.0'	WB				Dark brown silty clay, stiff
2.0'	3.0'	3.0'	WB				Brown silty clay, soft to med.
3.5'	4.0'	4.0'	SS1				Same
4.0'	5.0'	5.0'	WB				Same
5.0'	6.0'	6.0'	WB				Brown silty clay w/trace sand, soft
6.0'	7.0'	7.0'	SS2				Brown silty clay w/trace sand, soft
7.0'	8.0'	8.0'	WB				Brown & gray silty clay, soft to med.
8.0'	9.0'	9.0'	WB				Same
9.0'	10.0'	10.0'	WB				Gray silty clay, med.
10.0'	11.0'	11.0'	WB				Gray silty clay, soft to med.
11.0'	12.0'	12.0'	WB				Same
12.0'	13.0'	13.0'	WB				Gravel w/trace clay
13.0'	14.0'	14.0'	WB				Gray shale, hard
14.0'	15.0'	15.0'	WB				
15.0'	16.0'	16.0'	WB				
16.0'	17.0'	17.0'	WB				
17.0'	18.0'	18.0'	WB				
18.0'	19.0'	19.0'	WB				
19.0'	20.0'	20.0'	WB				
20.0'	21.0'	21.0'	WB				
21.0'	22.0'	22.0'	WB				
22.0'	23.0'	23.0'	WB				
23.0'	24.0'	24.0'	WB				
24.0'	25.0'	25.0'	WB				
25.0'	26.0'	26.0'	WB				
26.0'	27.0'	27.0'	WB				
27.0'	28.0'	28.0'	WB				
28.0'	29.0'	29.0'	WB				
29.0'	30.0'	30.0'	WB				
30.0'	31.0'	31.0'	WB				
31.0'	32.0'	32.0'	WB				
32.0'	33.0'	33.0'	WB				
33.0'	34.0'	34.0'	WB				
34.0'	35.0'	35.0'	WB				
35.0'	36.0'	36.0'	WB				
36.0'	37.0'	37.0'	WB				
37.0'	38.0'	38.0'	WB				
38.0'	39.0'	39.0'	WB				
39.0'	40.0'	40.0'	WB				
40.0'	41.0'	41.0'	WB				
41.0'	42.0'	42.0'	WB				
42.0'	43.0'	43.0'	WB				
43.0'	44.0'	44.0'	WB				
44.0'	45.0'	45.0'	WB				
45.0'	Total depth						

MARKS: (Casing Water Loss, Etc.)
 Speed for 1-1/2 hour - 6 GPM
 Static Water Level 4.8
 Time 9/14/81 (Completion)
 Date

Hyne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 1-4

TEST BORING LOG

Project Lake City AAP

Boring No. MW 1-4 Sheet 1 of 1

Surface Elevation 773.0 Offset _____

Address _____

Date Started 7/31/81 Completed 7/31/81

City & State Independence, Missouri

Driller T. Butler Rig _____

Abbreviations:

A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	2.5'	WB				Light brown silty clay, med. to stiff
2.5'	4.5'	WB				Light brown silty clay w/trace weathered shale, med. to stiff
4.5'	9.5'	WB				Weathered shale & Light brown clay, med. to stiff
9.5'	10.0'	SS1				Gray shaly clay, med. to stiff.
10.0'	10.5'	SS1		21-50/0.3		Light gray shale, med. to hard
10.5'	12.5'	WB				Light gray shale, med. to hard
12.5'	17.0'	WB				Light gray shale, soft to med.
17.0'	20.5'	WB				Light & dark gray shale, soft to med.
20.5'	24.0'	WB				Maroon shale, med. to stiff
24.0'	26.0'	WB				Maroon & gray shale, med. to stiff
26.0'	27.5'	WB				Gray shale, hard
27.5'	34.0'	WB				Same
34.0'	40.0'	WB				Gray shale, med. to hard
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date

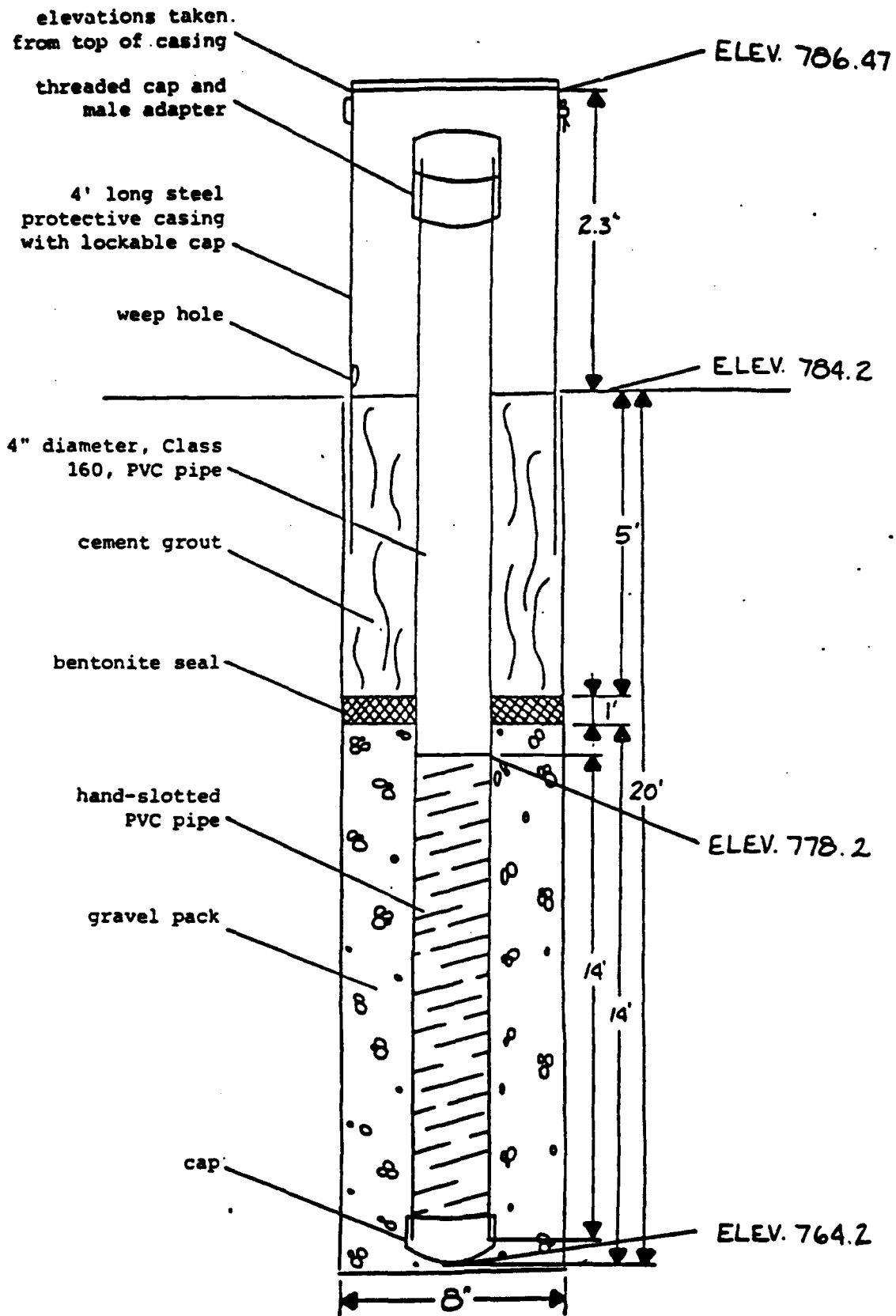
umped 1-1/2 hour - 1/2 GPM

4.2

9/14/81 (Completion)

ayne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 1-5

TEST BORING LOG

Project Lake City AAP

Boring No. MW 1-3 Sheet 1 of 1

Surface Elevation 784.2 Other _____

Date Started 9/4/81 Completed 9/8/81

Driller T. Butler Rig

Ad
City & State **Independence, Missouri**

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Silt Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Silt Tube F.B. - Finer Bit

[illegible]

MARKS: (Casing, Water Loss, Etc.)

bed 2 hours - 1/2 GPM

Static Water Level

1.5

Time

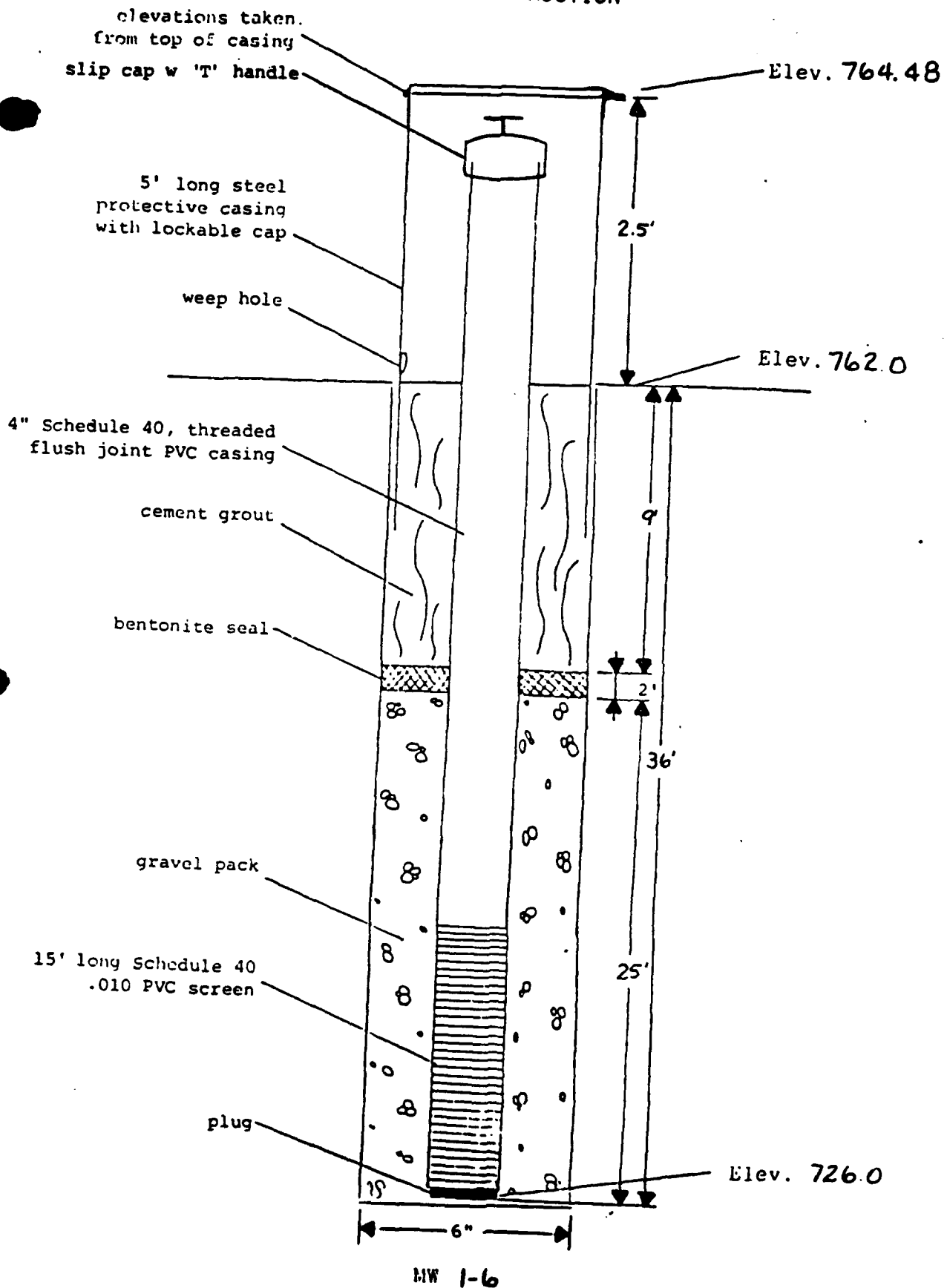
Date _____

9/11/81 (Completion)

Wyne-Western Company, Inc.

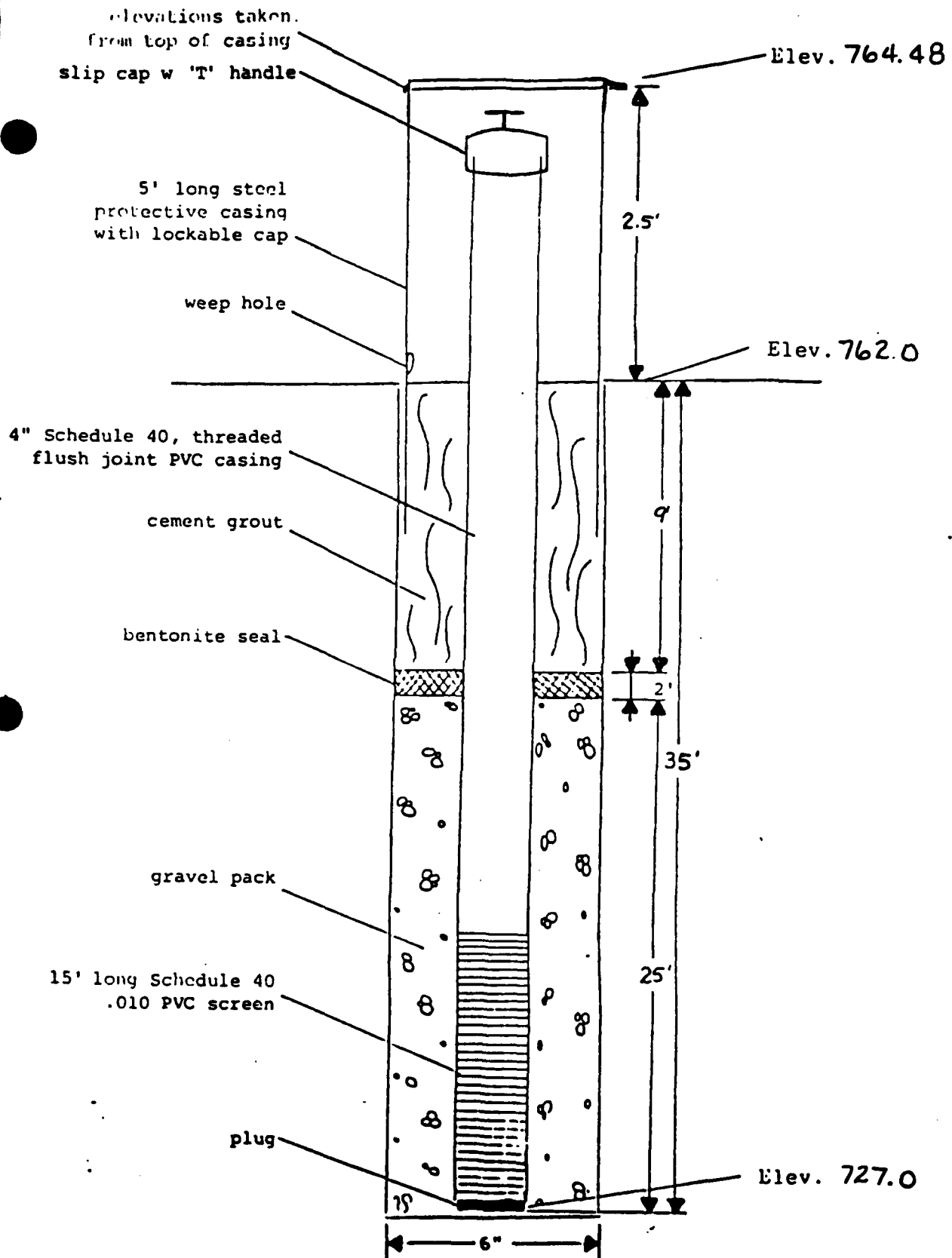
C-141

WELL CONSTRUCTION



MW 1-6

WELL CONSTRUCTION



HW 1-6

C-143

REPAIRING AND MAINTENANCE 2/10/77

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 1-6 Sheet 1 of 1

Surface Elevation 762.0 Offset

Date Started 12/7/82 Completed 12/7/82

City & State Independence, Missouri

Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

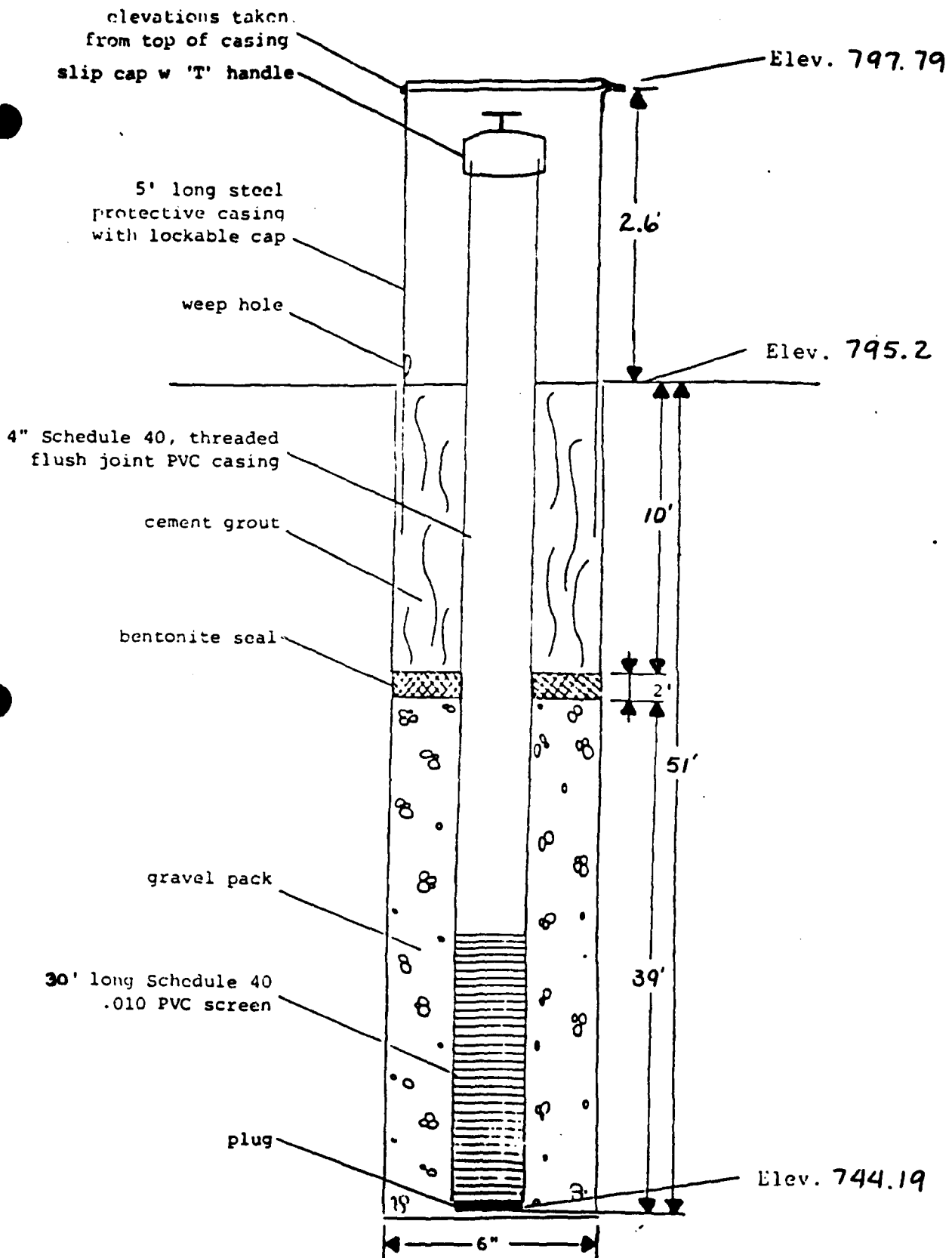
DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	1.0'	HA				Topsoil
1.0'	2.5'	HA				Dark brown silty clay, moist, med.
2.5'	4.5'	HA				Brown silty clay, moist, med.
4.5'	6.0'	ST1	0.75		1.2'	Brown & gray silty clay, moist, med.
6.0'	10.0'	HA				Same
10.0'	14.5'	HA				Same
14.5'	16.0'	ST2	1.25		1.5'	Brown & gray silty clay, moist, stiff
16.0'	18.3'	HA				Same
18.3'	24.5'	HA				Dark gray silty clay, moist, med.
24.5'	26.0'	ST3	1.0		1.5'	Same
26.0'	30.0'	HA				Same
30.0'	30.5'	HA				Light green shale, dry, med. to hard
30.5'	34.5'	HA				Same
34.5'	36.0'	SS1		20-50/0.4	0.9'	Same
36.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Water Level 11.5 Time 1:30pm Date 12/7/82 (Completion)

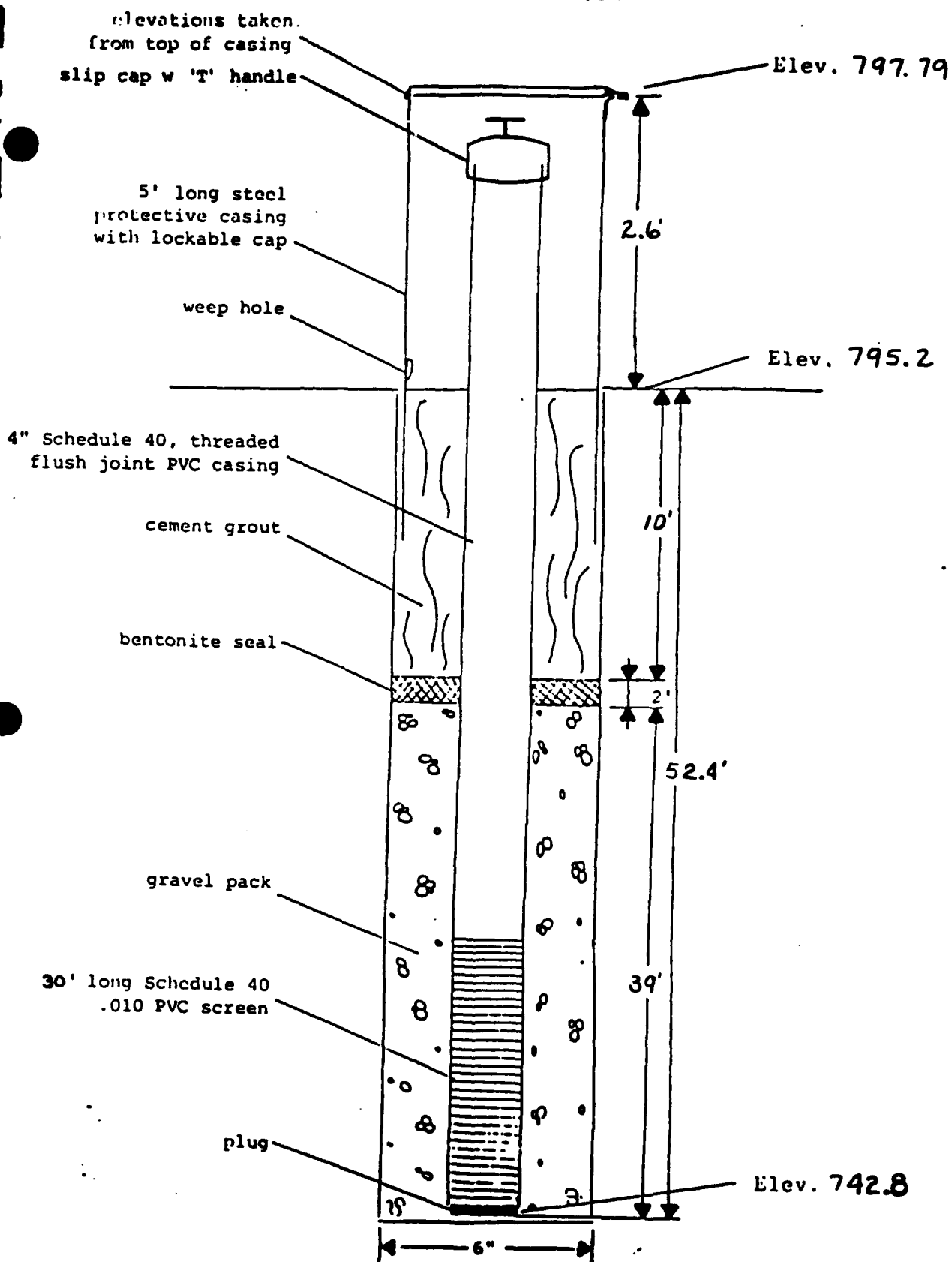
Water at 12.5'

WELL CONSTRUCTION



MW 1-7

WELL CONSTRUCTION



LW 1-7

TEST BORING LOG

Project Lake City Army Ammunition Plant Boring No. 1-7 Sheet 1 of 1
 Surface Elevation Approx. 795.0 Offset _____
 Date Started 12/8/82 Completed 12/8/82
 City & State Independence, Missouri Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	0.6'	HA				Topsoil
0.6'	1.5'	HA				Dark brown silty clay w/gravel (fill), moist, very stiff
1.5'	9.5'	HA				Brown silty clay, moist, very stiff
9.5'	11.0'	ST1	4.0		1.5'	Brown & gray silty clay, moist, very stiff
11.0'	18.0'	HA				Same
3.0'	19.5'	HA				Light brown & gray weathered shale, dry, med. hard
19.5'	20.1'	ST2	4.5+		0.6'	Same
20.1'	25.0'	HA				Brown & gray weathered shale, dry, med. to hard
25.0'	29.5'	HA				Same
29.5'	30.2'	SS1		20-50/0.2	0.7'	Brown & gray shale, dry, med. to hard
30.2'	32.0'	HA				Same
32.0'	41.5'	HA				Same
41.5'	47.0'	HA				Maroon shale, dry, med. to hard
47.0'	54.5'	HA				Gray shale, dry, med. to hard
54.5'	Refusal					

ARKS: (Casing, Water Loss, Etc.)

Water Level Time Date
 Dry 11:45am 12/8/82 (Completion)

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 1-7 Sheet 1 of 1

Surface Elevation 795.2 Offset 10' S. of 1-7

Date Started 12/13/82 **Completed** 12/14/82

City & State Independence, Missouri

Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wash
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

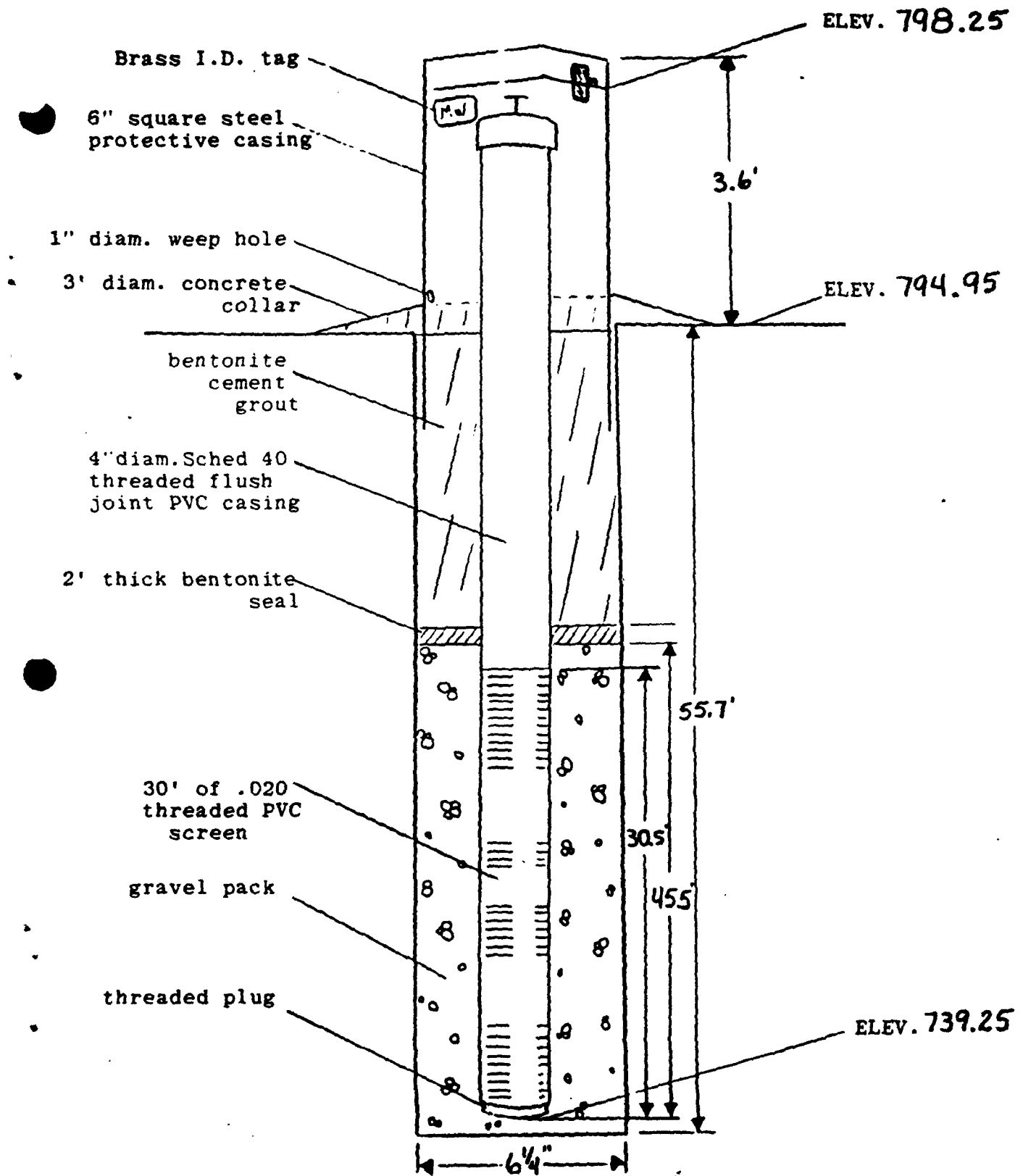
Date

Dry

9:30am

12/14/82 (Completion)

WELL CONSTRUCTION



MW 1-7A

TEST BORING LOG

Project Lake City Army Ammunition Plant Boring No. 1-7A Sheet 1 of 1
Replacement Wells Surface Elevation _____ Offset _____
 Address _____ Date Started 6/25/85 Completed 7/02/85
 City & State Independence, Missouri Driller Buck Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit*

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0	0.6	HA				Topsoil
0.6	2.5	HA				Dark brown silty clay, moist, stiff
2.5	4.0	HA				Brown silty clay, moist, stiff
4.0	11.5	HA				Light brown clayey silt, moist, stiff
11.5	17.3	HA				Light brown clayey silt, with trace sand moist, very stiff
17.3	22.5	HA				Olive-brown shale, dry, medium to hard
22.5	24.3	HA				Same, with thin sandstone seams
24.3	24.7	HA				Gray shale with thin limestone seams, hard
24.7	32.0	HA				Olive-brown shale, dry, medium to hard
32.0	37.1	HA				Dark gray shale, dry, medium to hard
37.1	47.1	HA				Marroon shale, dry, medium to hard
47.1	47.4	HA				Dark gray limestone
47.4	57.0	HA				Gray shale, dry, medium to hard
57.0	Total Depth					

REMARKS: (Casing, Water Loss, Etc.)

Water level measured from top of casing

Water Level

Time

Date

19.7'

3:30 pm

7/2/85

(Completion)

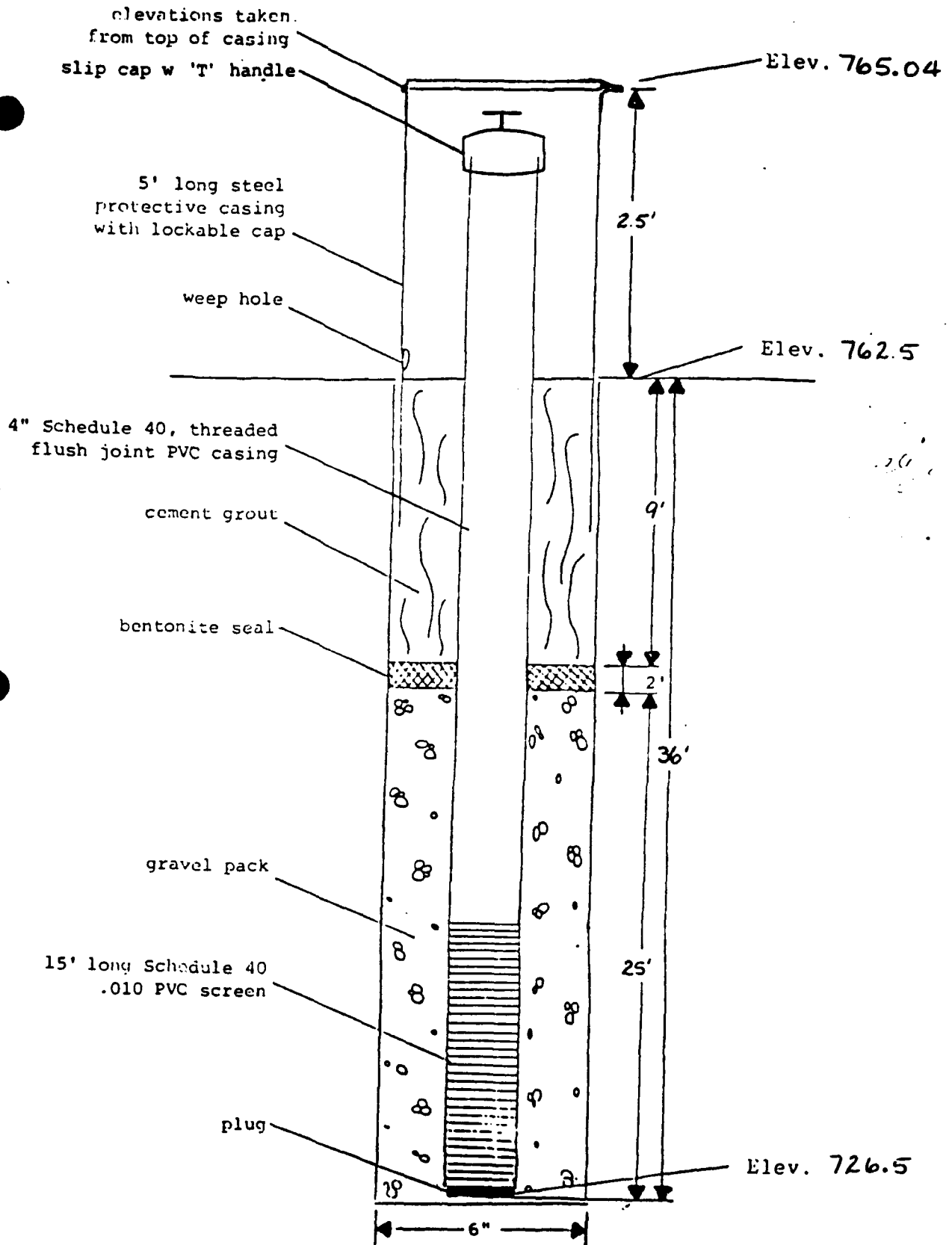
15.8'

4:45 pm

7/3/85

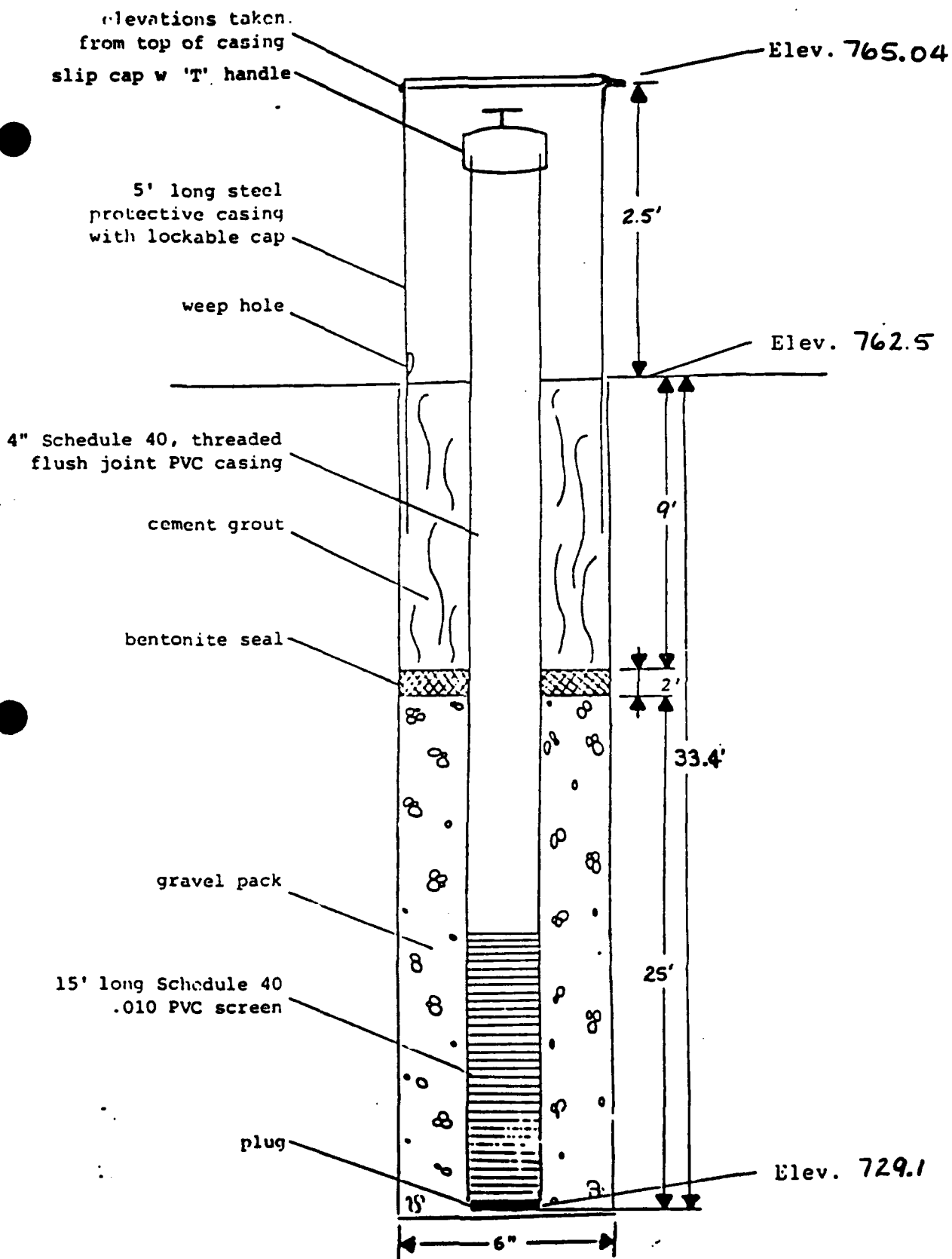
Wyne-Western Company, Inc.

WELL CONSTRUCTION



MW 1-8

WELL CONSTRUCTION



HW 1-8

C-152

Perkins & Associates, Inc.

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 1-8 Sheet 1 of 1

Surface Elevation 762.5 Offset _____

Date Started 12/8/82 Completed 12/8/82

City & State Independence, Missouri

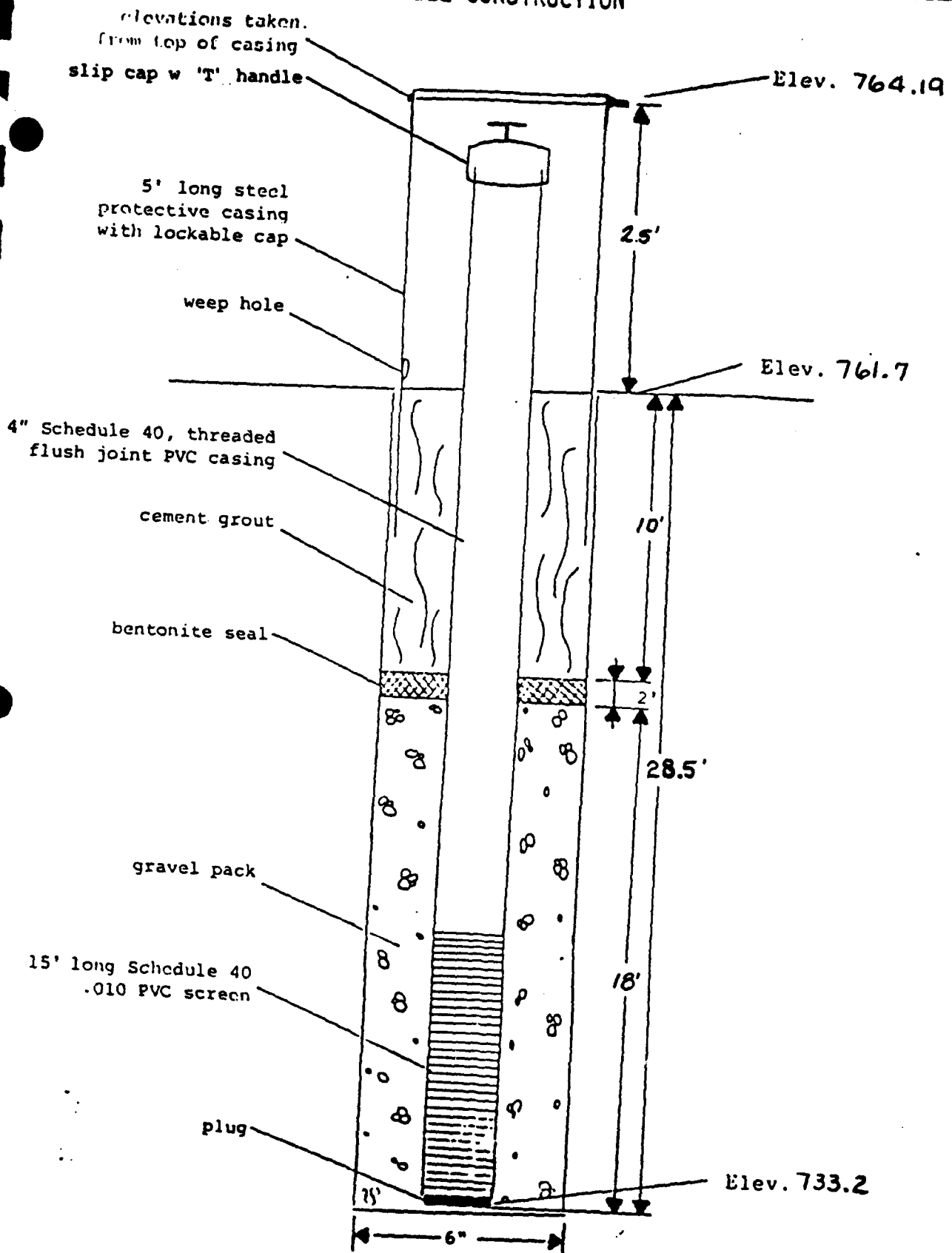
Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	1.5'	HA				Brown silty clay w/weathered shale (fill) moist, med.
1.5'	7.5'	HA				Dark brown silty clay, moist, med.
7.5'	9.5'	HA				Brown & gray silty clay, moist, stiff
9.5'	11.0'	ST1	1.25		1.5'	Same
11.0'	15.0'	HA				Same
15.0'	19.5'	HA				Same
19.5'	21.0'	ST2	0.75		1.2'	Brown & gray silty clay, moist, med.
21.0'	28.0'	HA				Same
28.0'	34.5'	HA				Dark gray very silty clay, moist, med.
34.5'	36.0'	ST3	1.0		1.5'	Same
36.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.) _____ Water Level _____ Time _____ Date _____
 _____ (Completion)

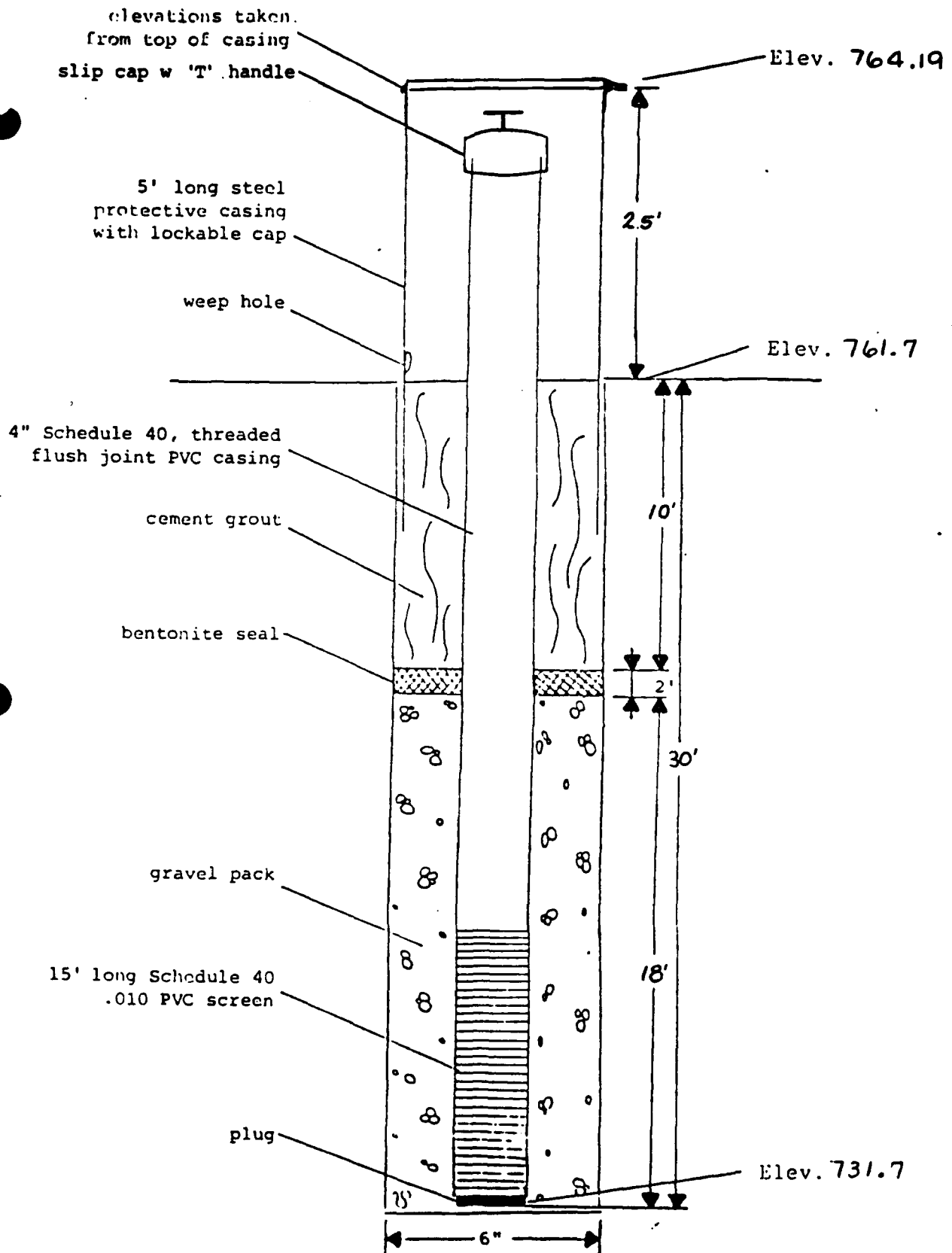
WELL CONSTRUCTION



MW 1-9

C-154

WELL CONSTRUCTION



MW 1-9

TEST BORING LOG

Project Lake City Army Ammunition Plant Boring No. MW 1-9 Sheet 1 of 1
 Surface Elevation 761.7 Offset _____
 Date Started 12/9/82 Completed 12/9/82
 City & State Independence, Missouri Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO. METER	NO. OF BLOWS		
0.0'	4.0'	HA				Dark brown silty clay, moist, med.
4.0'	9.5'	HA				Brown silty clay, moist, med.
9.5'	11.0'	ST1	0.75		1.3'	Brown & gray silty clay, moist, med..
11.0'	15.0'	HA				Same
15.0'	20.0'	HA				Same
20.0'	21.5'	HA				Same
21.5'	24.5'	HA				Dark gray silty clay, moist, stiff
24.5'	26.0'	ST2	1.25		1.5'	Same
26.0'	30.0'	HA				Same
30.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Water Level

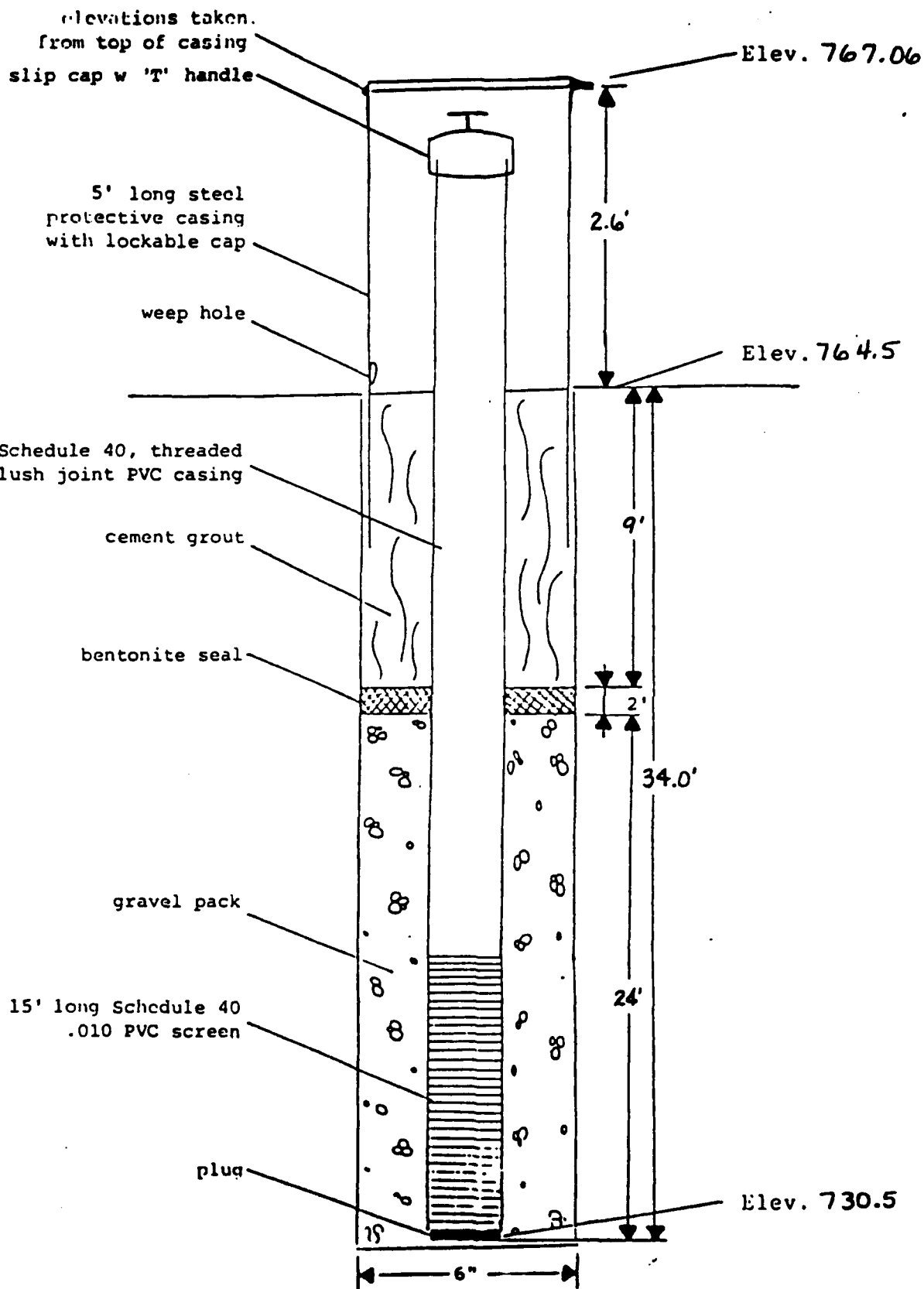
Time

Date

Hit water at approximately 11.0'

(Completion)

WELL CONSTRUCTION

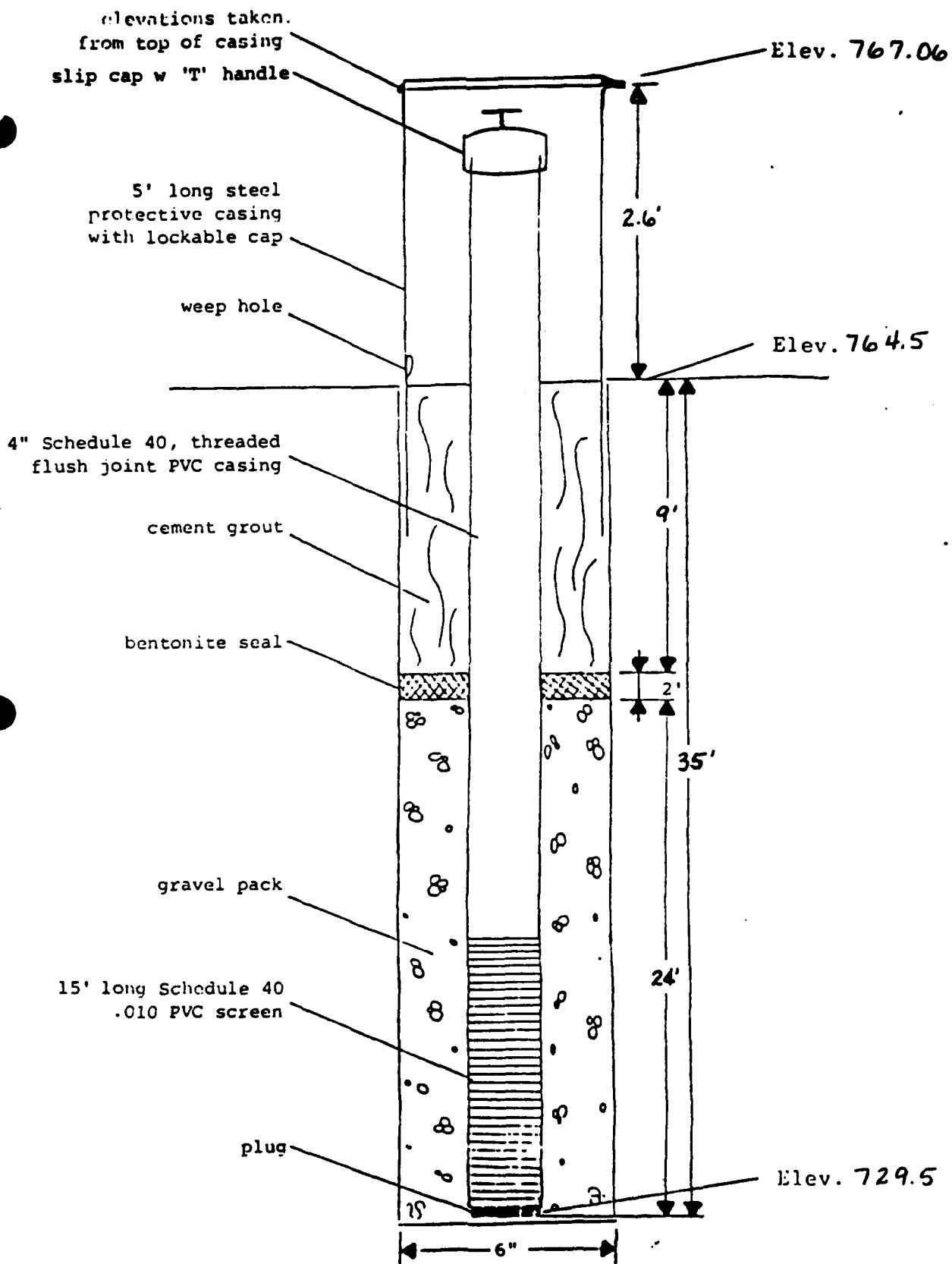


MW 1-10

C-157

D.

WELL CONSTRUCTION



HW 1-10

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 1-10

Sheet 1 of 1

Surface Elevation **764.5**

Offset

Date Started 1/10/83

Completed 1/10/83

City & State Independence, Missouri

Driller B. Blank

Rig AD-2

Abbreviations:

A.O. - Auger Only

R.B. - Rock Bit

C.W. - Core Water

H.A. - Hollow Auger
W.B. - Wash Bore

S.S. - Split Spoon
S.T. - Shelby Tube

C.A. - Core Air
F.B. - Finger Bit

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

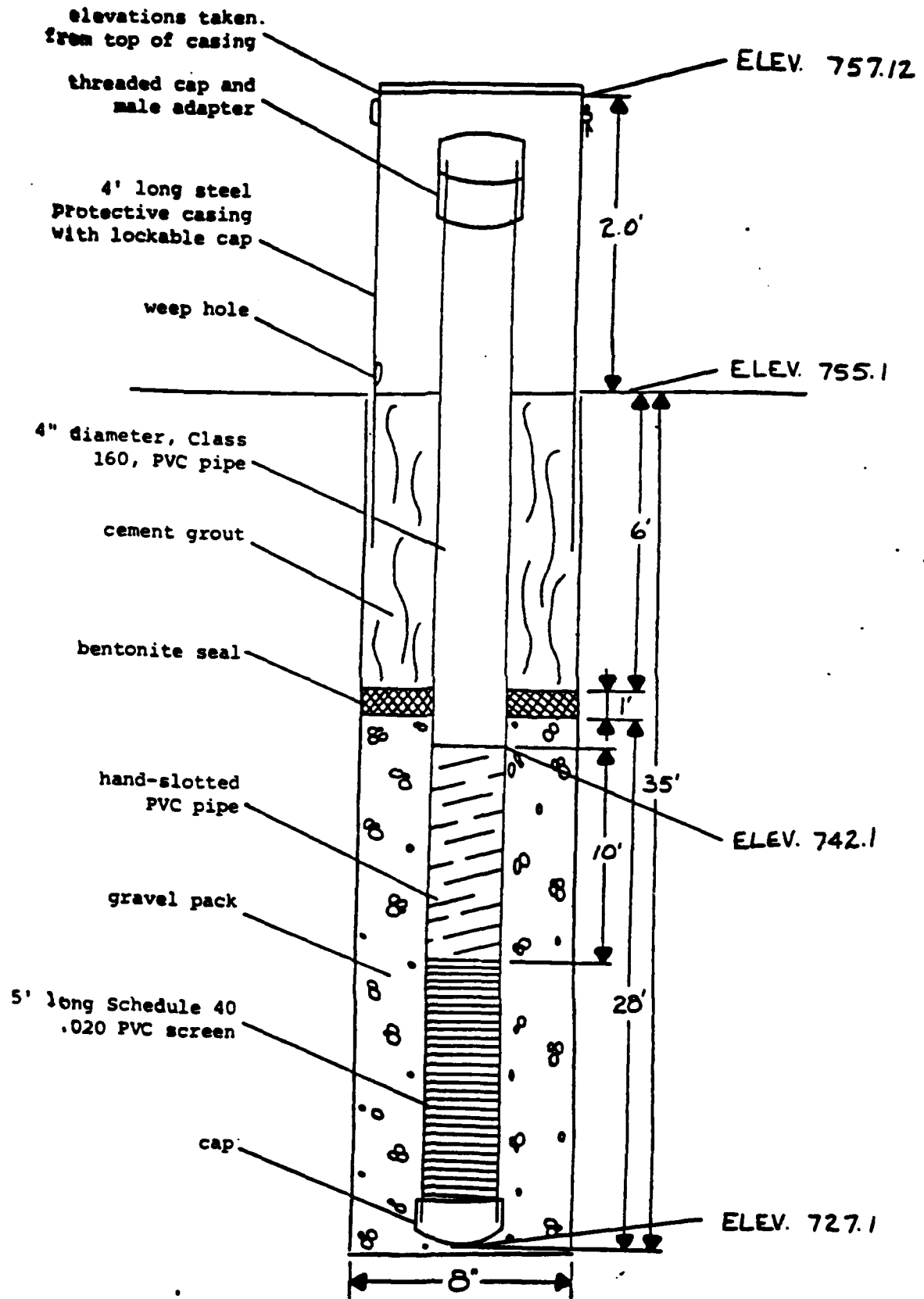
Date

B.2

12:00pm

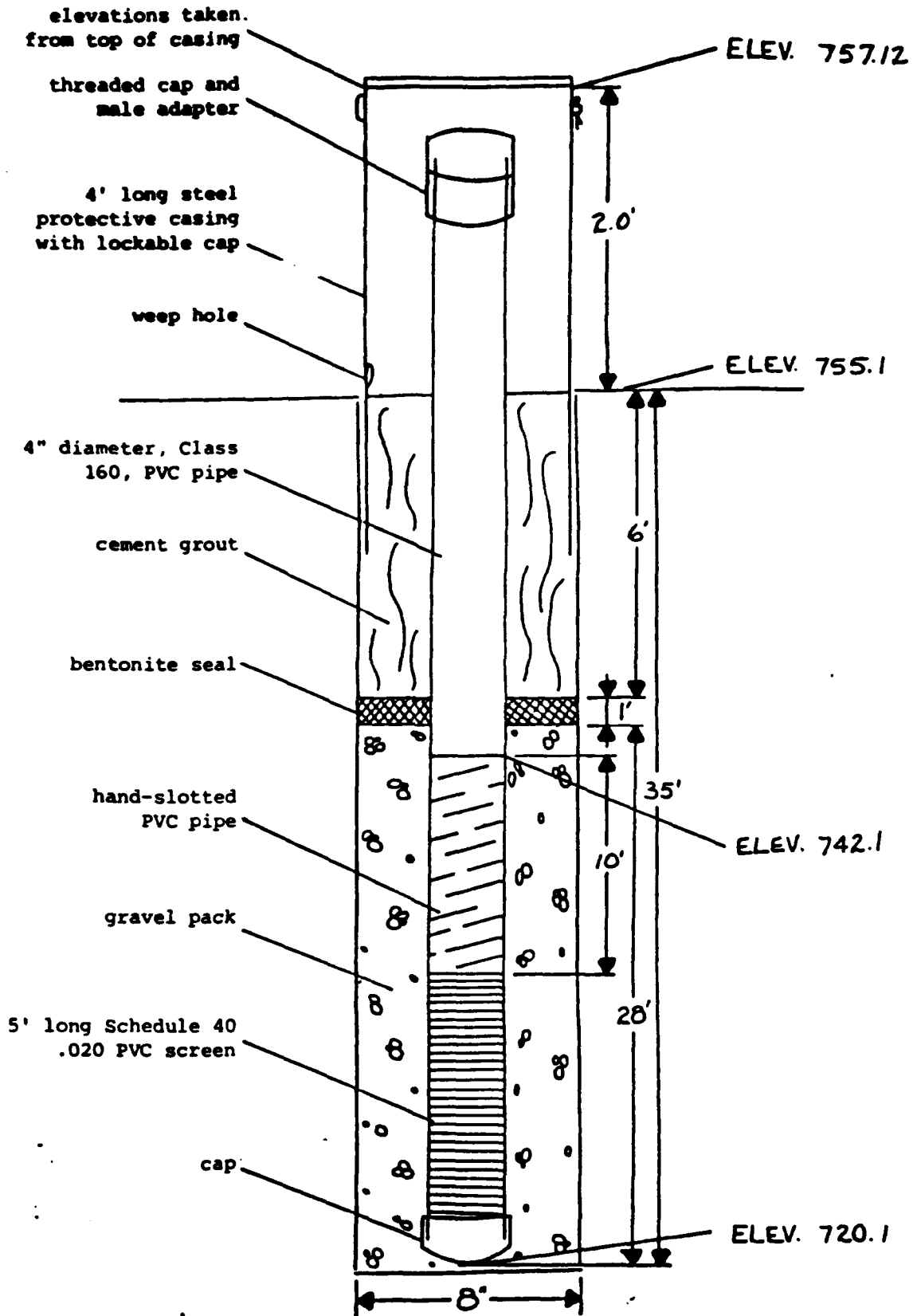
1/10/83 (Completion)

CONSTRUCTION OF WELL



MW 2-1

CONSTRUCTION OF WELL



MW 2-1

Pro

P

Surface Elevation 755.1 Offset

Date Started 8/4/81 Completed 8/4/81

Driller **D. Vogt** Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

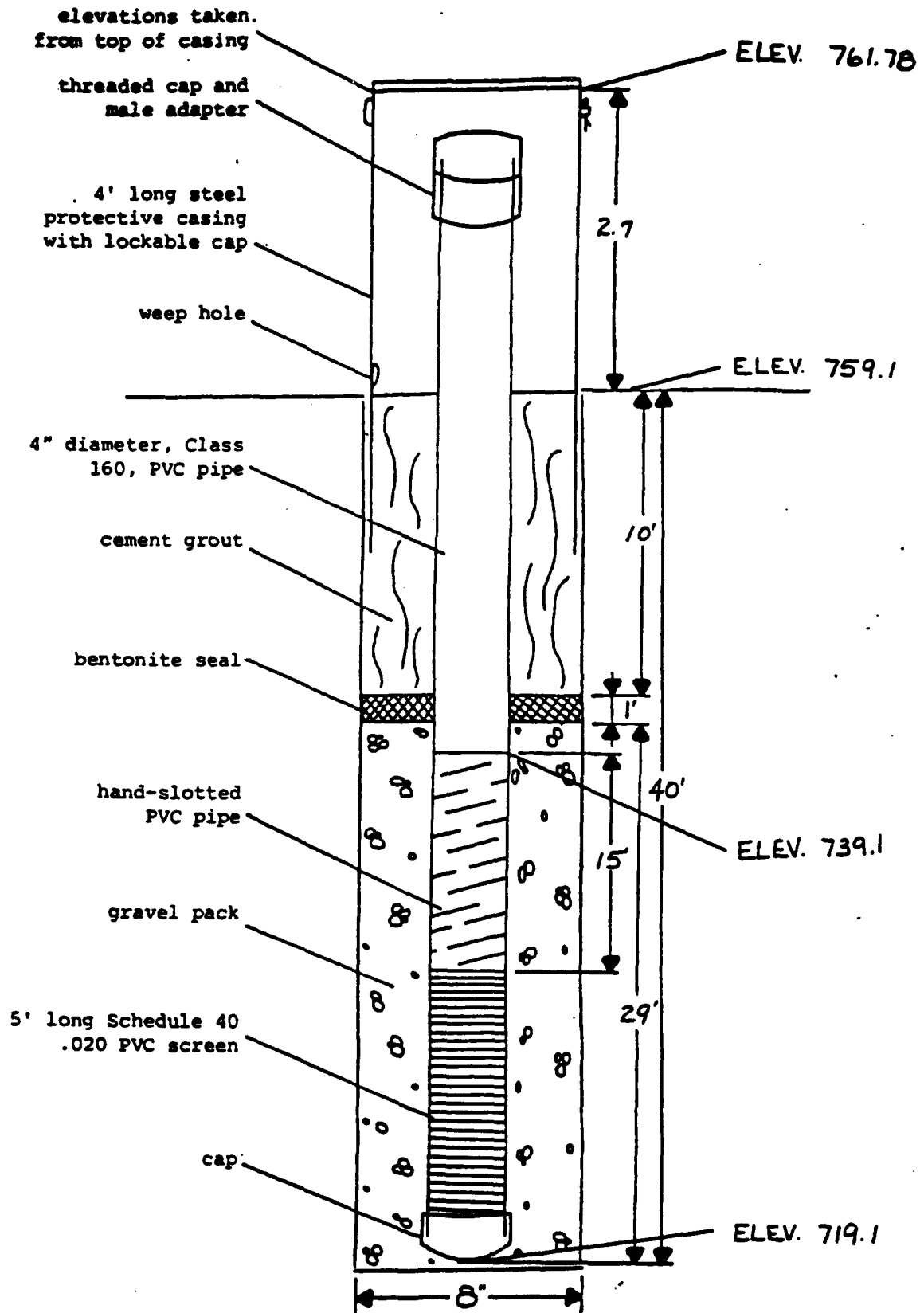


Static Water Level	Time	Date
2.9		9/11/81 (Completion)

Pumped 1 hour - 2-1/2 GPM

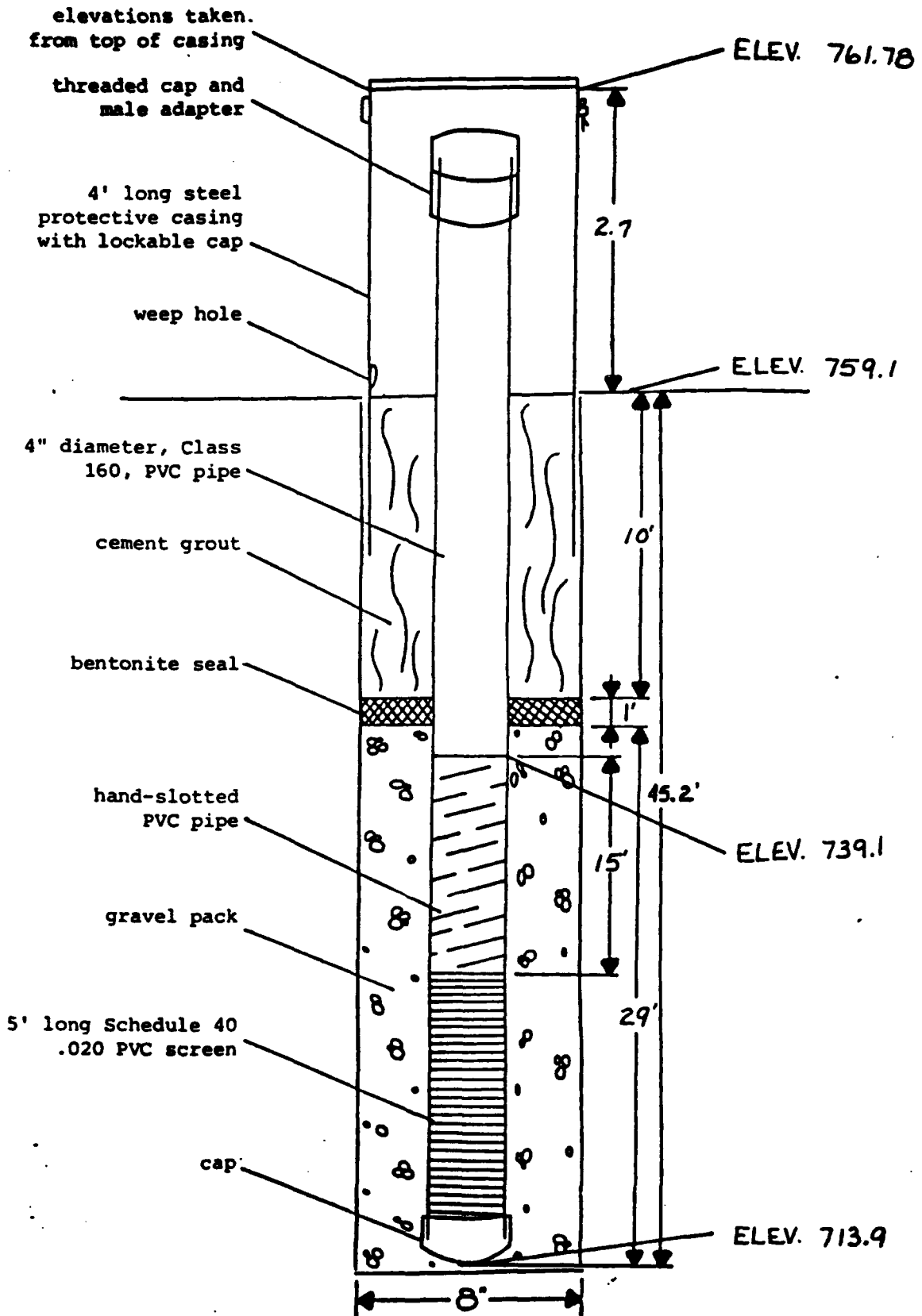
Gayne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 2-2

CONSTRUCTION OF WELL



MW 2-2

TEST BORING LOG

Project Lake City AAP Boring No. MW 2-2 Sheet 1 of 1

Surface Elevation 759.1 Offset _____

Date Started 8/4/81 Completed 8/4/81

City & State Independence, Missouri Driller D. Vogt Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

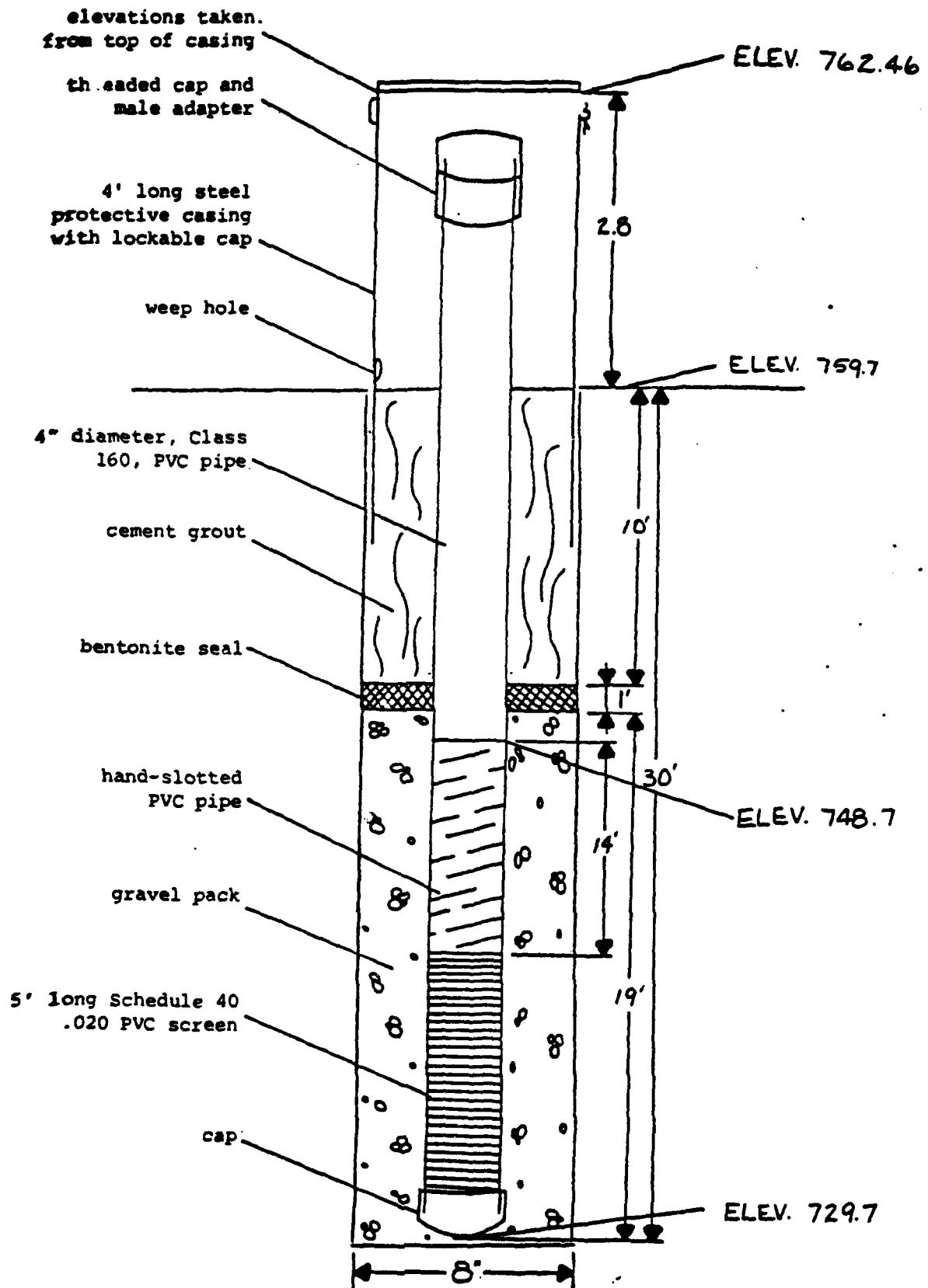
umped 1 hour - 7 GPM

7.2

Date _____

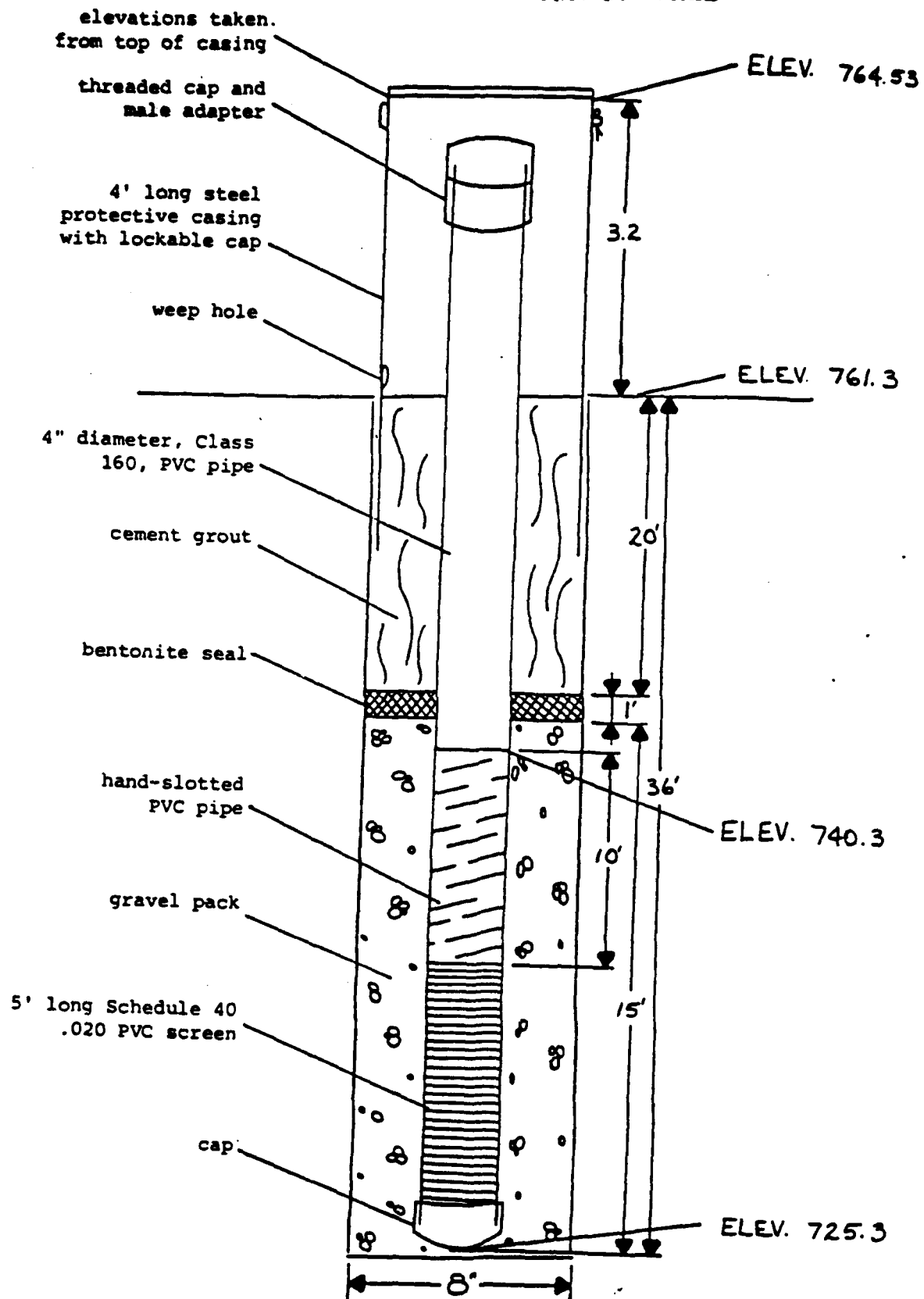
9/11/81 (Completion)

CONSTRUCTION OF WELL



MW 2-3

CONSTRUCTION OF WELL



MW 2-4

TEST BORING LOG

Project Lake City AAP

Boring No. MW 2-4 Sheet 1 of 1

Surface Elevation 761.3 Offset _____

Date Started 8/7/81 Completed 8/7/81

City & State Independence, Missouri

Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.5'	WB				Topsoil
1.5'	3.0'	WB				Light brown silty clay, soft to med.
3.0'	9.5'	WB				Dark gray silty clay, soft to med.
9.5'	11.0'	ST1	1.5			Dark gray silty clay, stiff
11.0'	14.5'	WB				Gray silty clay, soft to med.
14.5'	19.5'	WB				Tan silty clay, soft to med.
19.5'	21.0'	ST2	1.5			Tan & gray silty clay, stiff
21.0'	22.5'	WB				Gray silty clay, med. to stiff
22.5'	29.5'	WB				Tan silty clay w/trace sand, soft to me
29.5'	33.5'	WB				Tan silty clay, med. to stiff
33.5'	40.0'	WB				Tan silty clay, soft to med.
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static
Water Level

Time

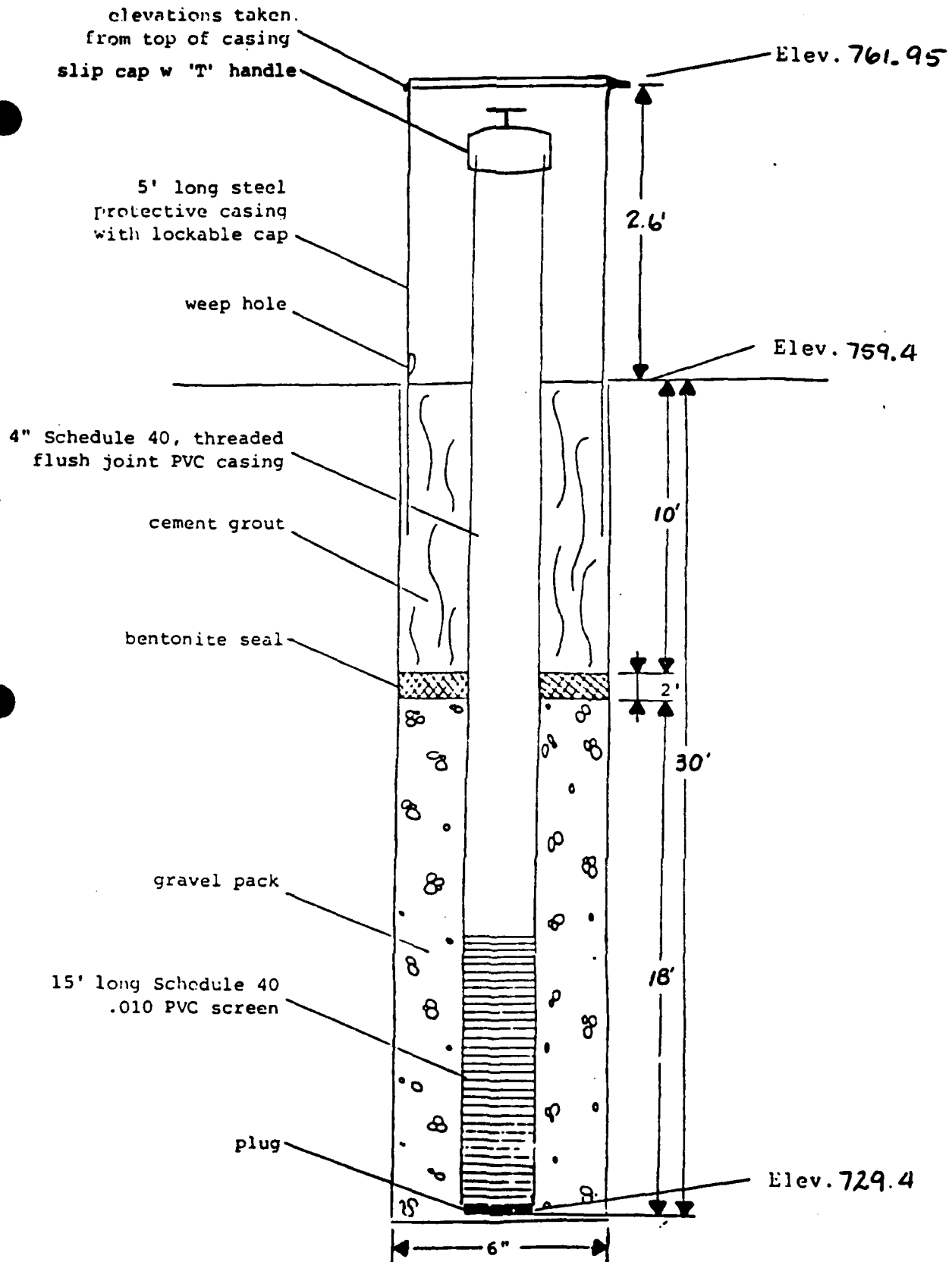
Date

pumped 1 hour - 2-1/2 GPM

3.0

9/11/81 (Completion)

WELL CONSTRUCTION



LW 2-5

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 2-5

Sheet 1 of 1

Surface Elevation 759.4

Offset _____

Address _____

Date Started 12/9/82

Completed 12/9/82

City & State Independence, Missouri

Driller B. Blank

Rig AD-2

Abbreviations:

A.O. - Auger Only

R.B. - Rock Bit

C.W. - Core Water

H.A. - Hollow Auger

S.S. - Split Spoon

C.A. - Core Air

W.B. - Wash Bore

S.T. - Shelby Tube

F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	0.6'	HA				Topsoil
0.6'	5.0'	HA				Brown silty clay, moist, med.
5.0'	9.5'	HA				Same
9.5'	11.0'	ST1	0.75		1.0'	Brown & gray silty clay, moist, med.
11.0'	15.0'	HA				Same
15.0'	20.0'	HA				Same
20.0'	22.5'	HA				Same
22.5'	24.5'	HA				Brown & gray silty clay, moist, very stiff
24.5'	26.0'	ST2	2.25		1.5'	Same
26.0'	30.0'	HA				Same
30.0'	Total depth					

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

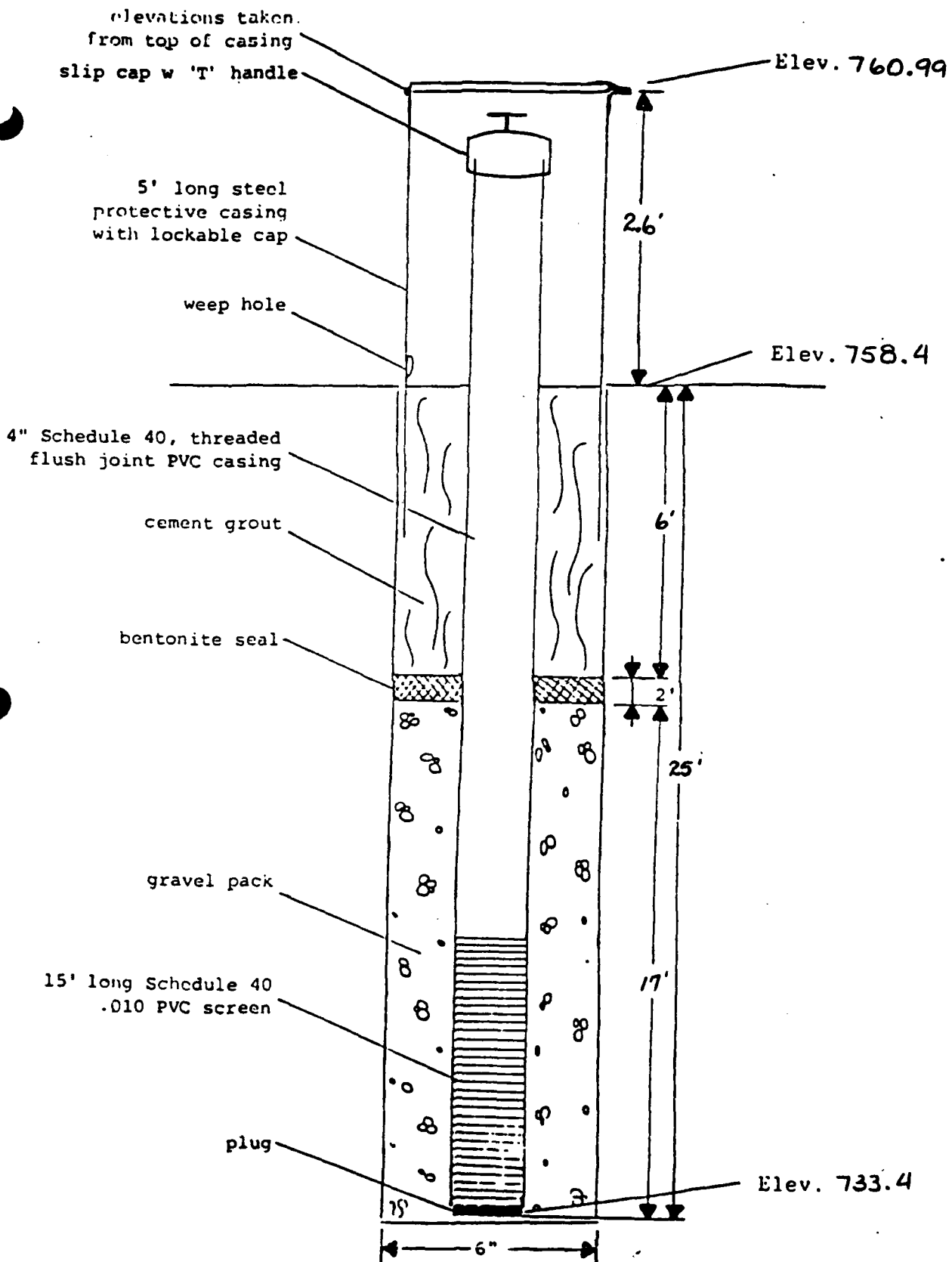
Water at approximately 11.0'

(Completion)

Layne-Western Company, Inc.

C-171

WELL CONSTRUCTION



MTW 2-6

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. **MW 2-6** Sheet **1** of **1**

Surface Elevation 758.4 Offset

Address _____

Date Started 12/13/82 Completed 12/13/82

City & State **Independence, Missouri**

Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**REMARKS. (Casing, Water Loss, Etc.)**

Water Level

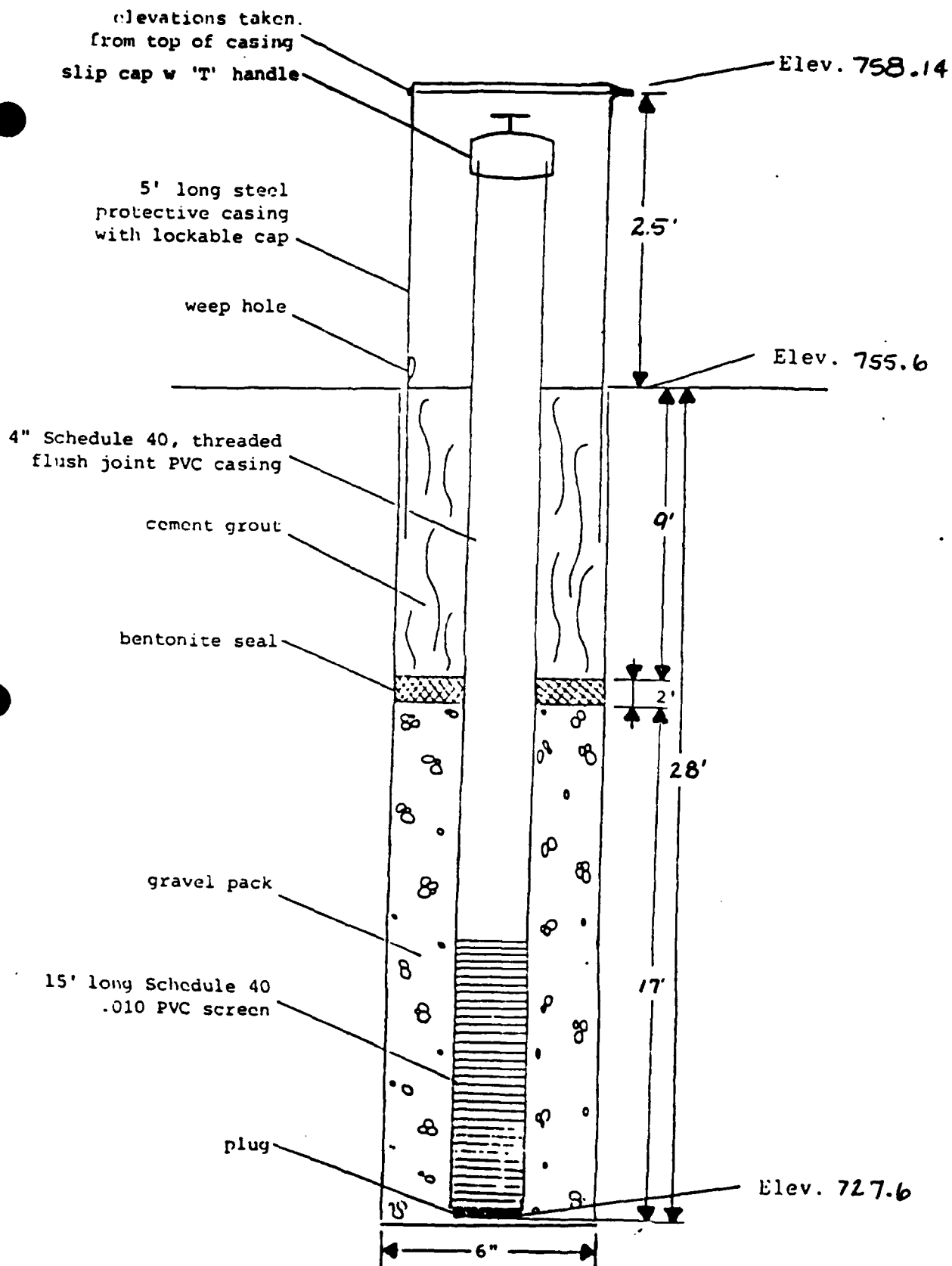
Time

Date _____

10.0'

(Completion)

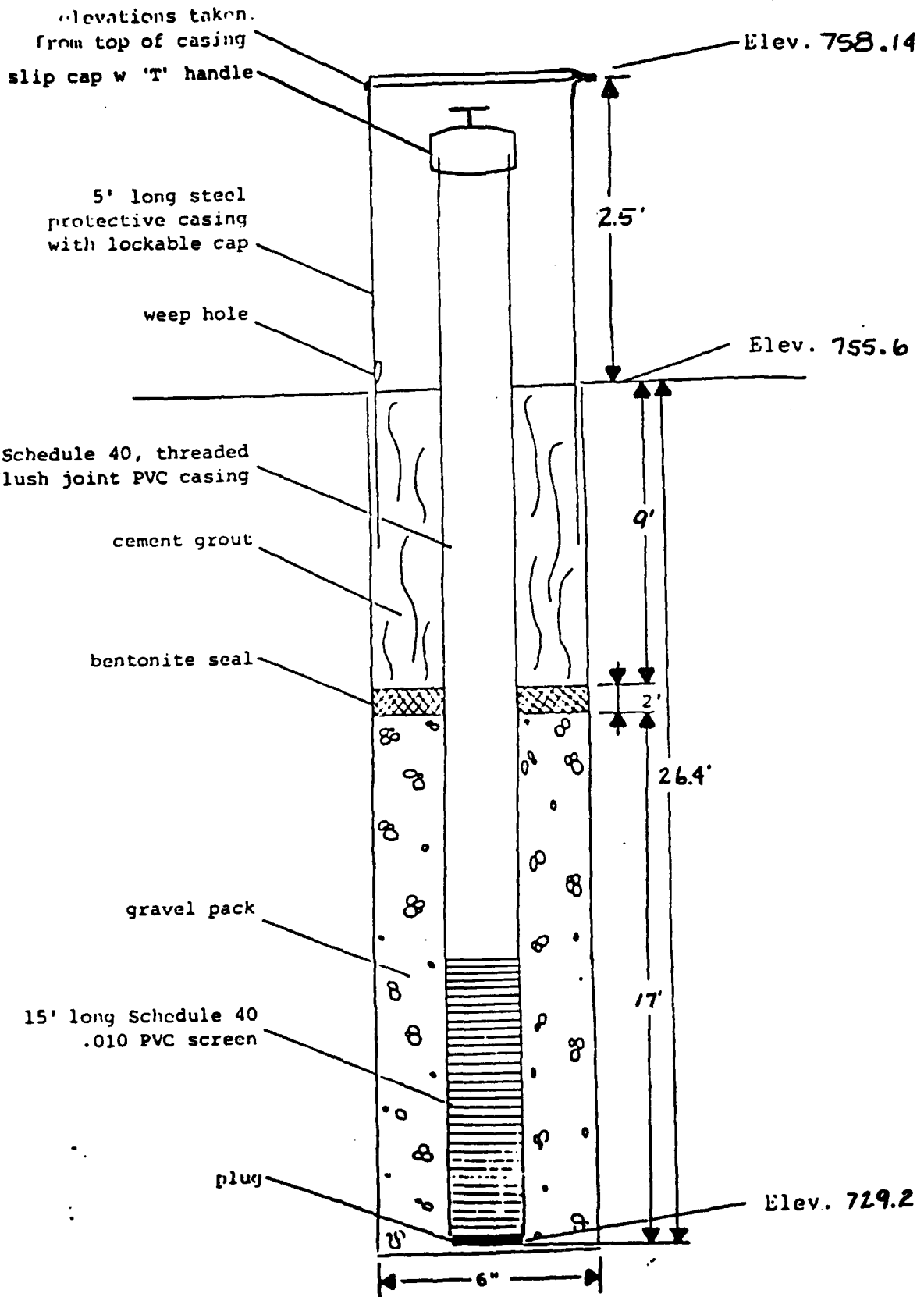
WELL CONSTRUCTION



NW 2-7

C-174

WELL CONSTRUCTION



MW 2-7

C-175

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 2-7 Sheet 1 of 1

Surface Elevation 755.6 Offset

Address _____

Date Started 1/10/83 **Completed** 1/10/83

City & State Independence, Missouri

Driller B. Blank Rig CME-55

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit[®]

[illegible]**MARKS: (Casing, Water Loss, Etc.)**

Water Level

Time

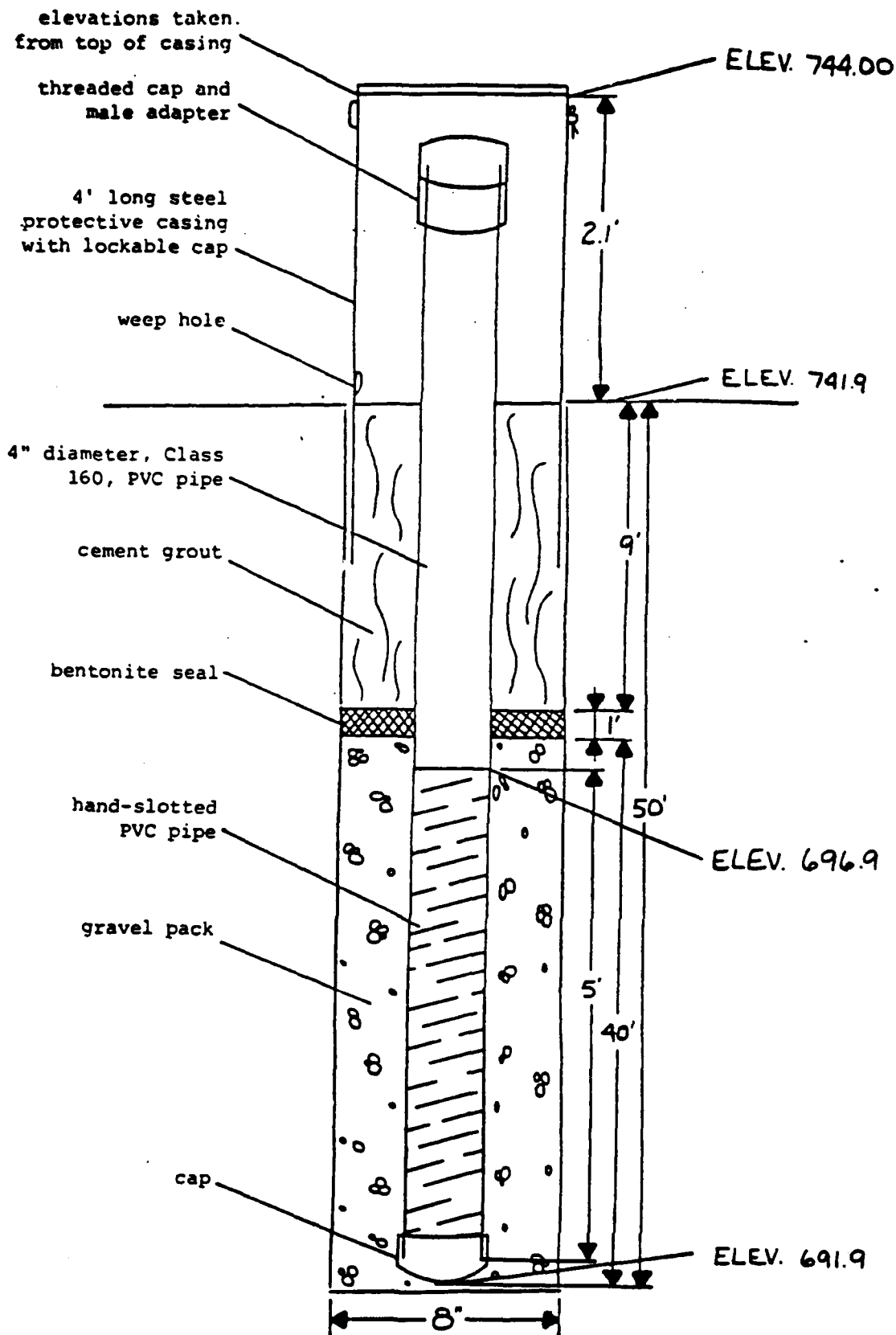
Date

8.7

12:15pm

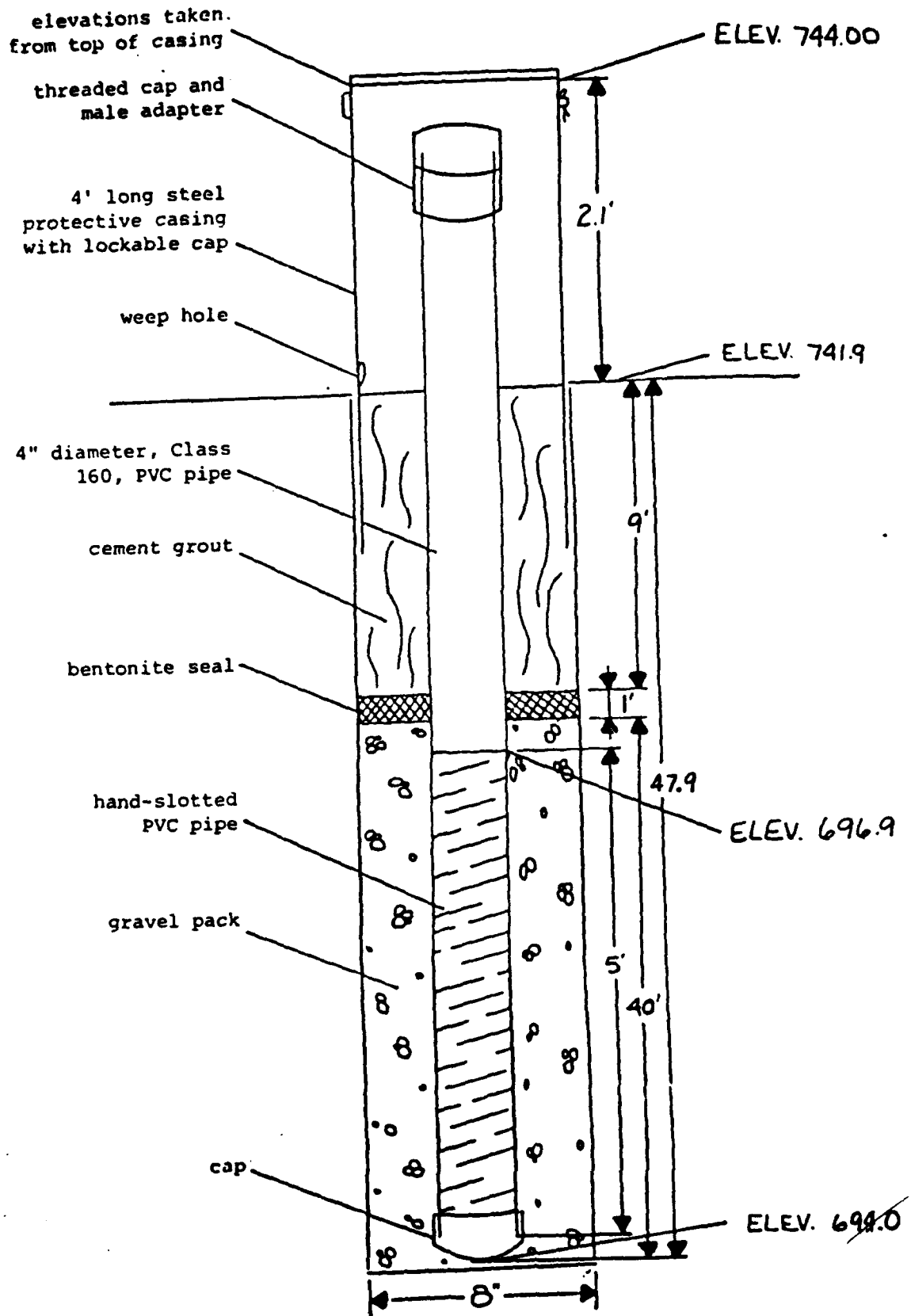
1/10/83 (Completion

CONSTRUCTION OF WELL



MW 3-1

CONSTRUCTION OF WELL



MW 3-1

TEST BORING LOG

Project Lake City AAP

Boring No. MW 3-1

Sheet 1 of 1

Surface Elevation 741.9

Offset

Depth

Date Started 9/23/81

Completed 9/23/81

City & State Independence, Missouri

Driller B. Blank

Rig

Abbreviations:

A.O. - Auger Only

R.B. - Rock Bit

C.W. - Core Water

H.A. - Hollow Auger

S.S. - Split Spoon

C.A. - Core Air

W.B. - Wash Bore

S.T. - Shelby Tube

F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Brown silty clay, very stiff
5.0'	10.0'	WB				Gray and brown fine to medium sand, med. dense
10.0'	11.0'	WB				Same
11.0'	15.0'	WB				Brown and gray sandy silt w/trace clay stiff
15.0'	20.0'	WB				Same
20.0'	22.0'	WB				Same
22.0'	25.0'	WB				Gray and brown fine sand, loose
25.0'	30.0'	WB				Same
30.0'	35.0'	WB				Same
35.0'	40.0'	WB				Same
40.0'	45.0'	WB				Gray fine sand w/trace coarse sand, med. dense
45.0'	50.0'	WB				Same
50.0'	Total depth					

RKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date

Pumped 2 hrs. - 6 2/3 GPM

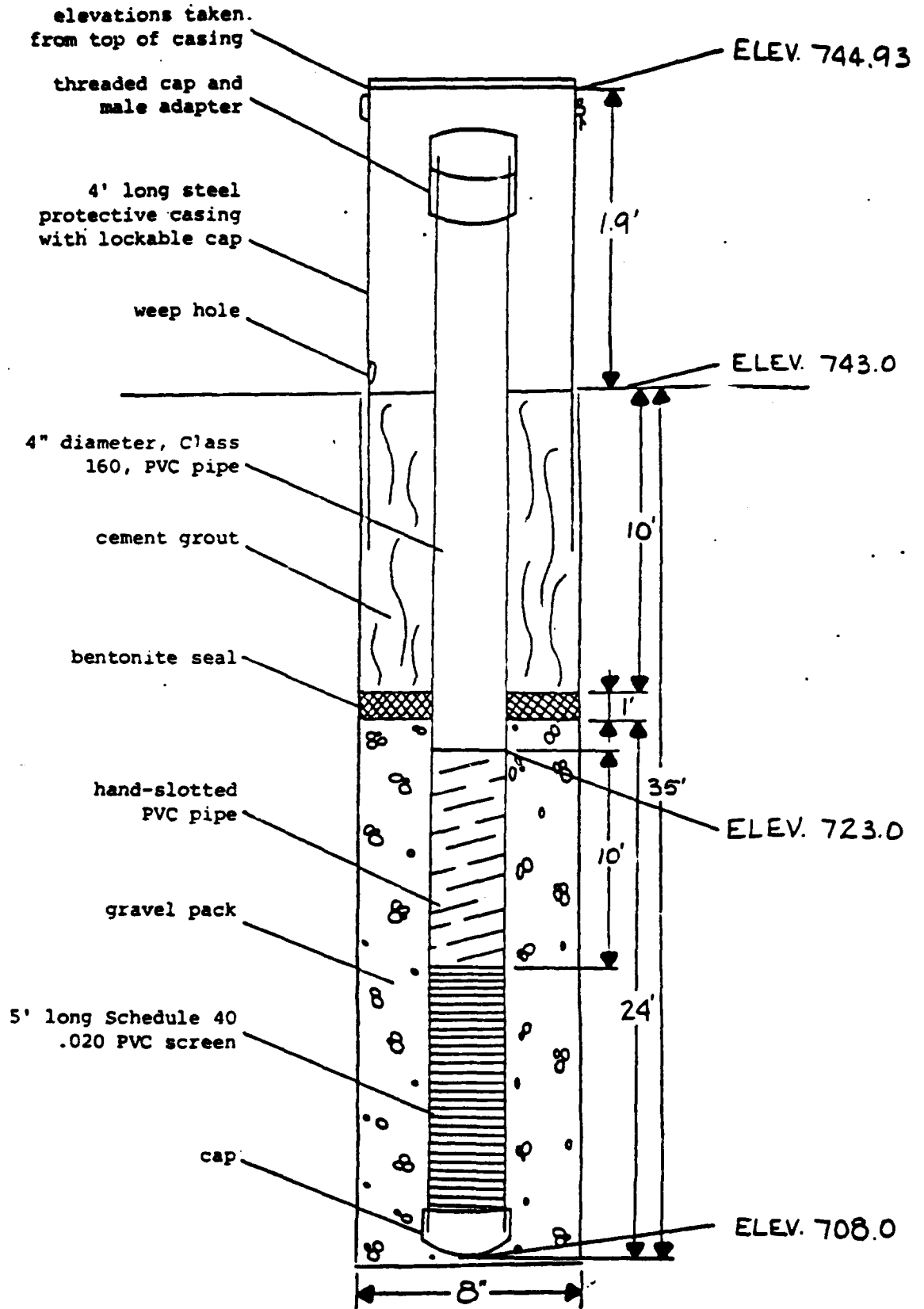
28.0

9/23/81

Completed

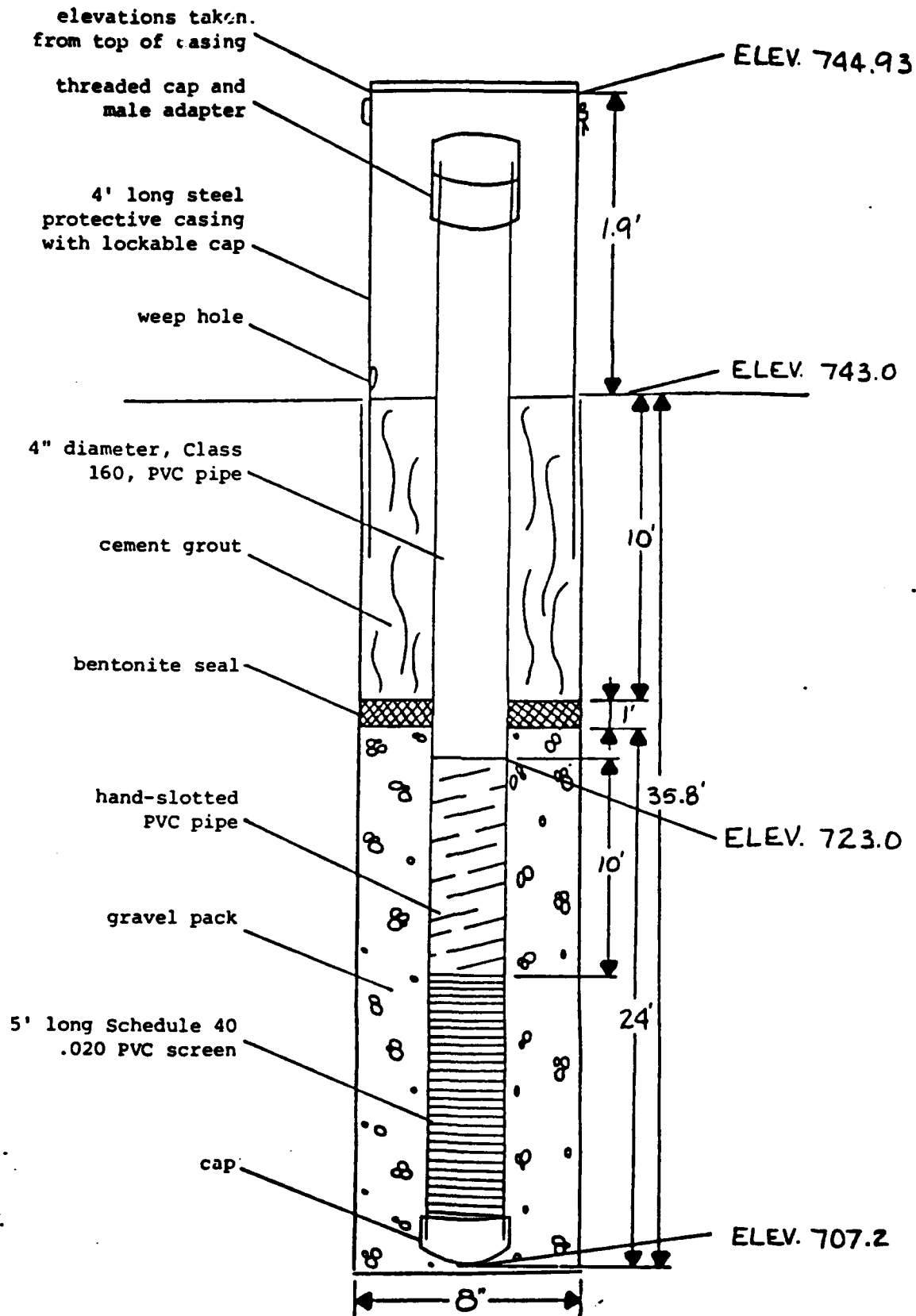
Byne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 3-2

CONSTRUCTION OF WELL



MW 3-2

TEST BORING LOG

Project Lake City AAPBoring No. MW 3-2 Sheet 1 of 1Surface Elevation 743.0 Offset _____Date Started 8/17/81 Completed 8/17/81City & State Independence, MissouriDriller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Dark brown silty clay, stiff
5.0'	6.0'	WB				Same
6.0'	9.0'	WB				Brown & gray silty clay w/trace sand, stiff
9.0'	10.5'	ST1	1.75			Same
10.5'	15.0'	WB				Same
	19.0'	WB				Same
19.0'	20.5'	ST2				Dark brown clayey fine to med. sand, dense
20.5'	25.0'	WB				Same
25.0'	30.0'	WB				Same
30.0'	35.0'	WB				Gray clayey fine sand, dense
35.0'	40.0'	WB				Same
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Pumped 2 hours - 1/2 GPM

Static
Water Level

28.3

Time

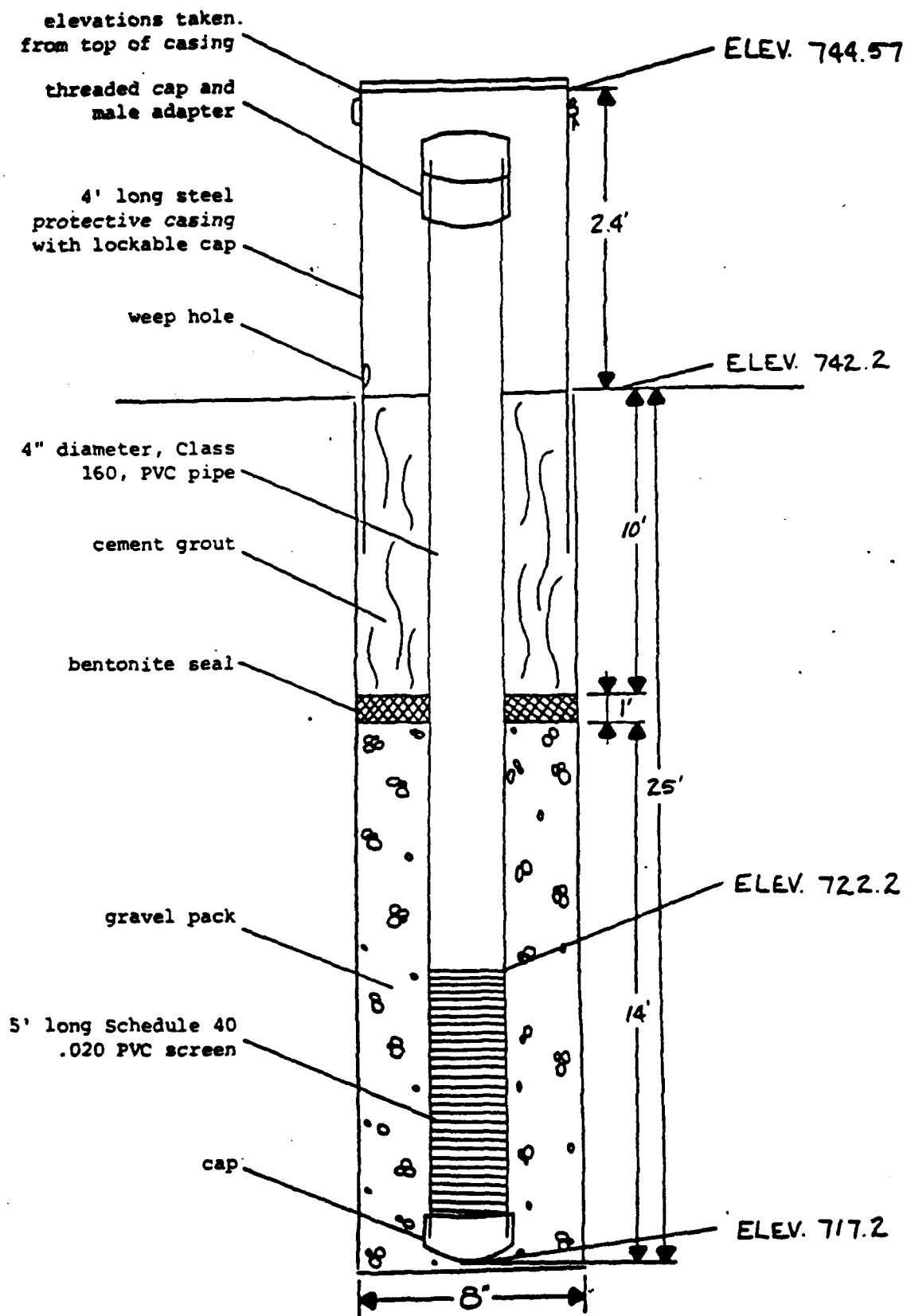
Date

9/10/81

(Completion)

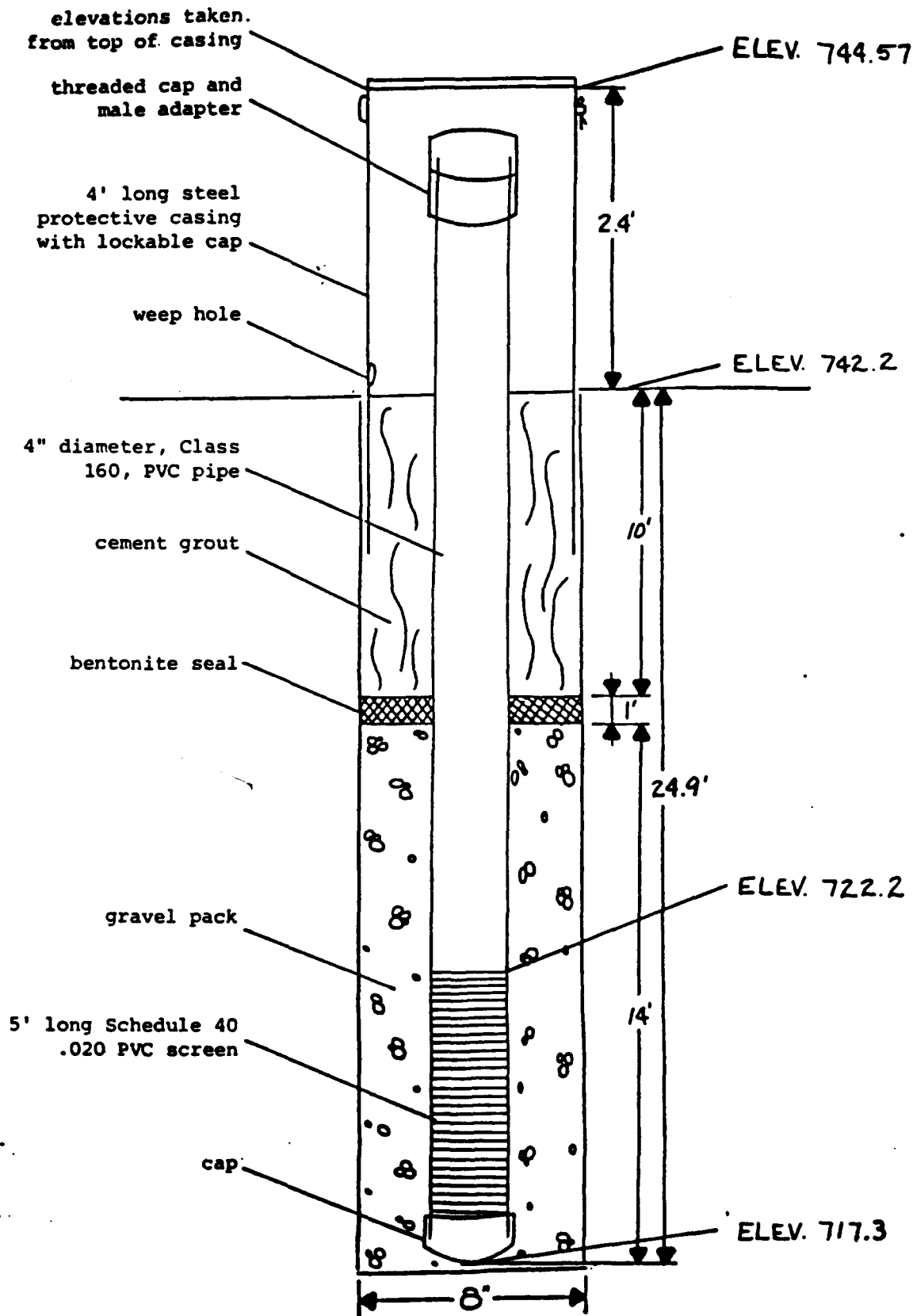
Geotechnical Engineering, Inc.

CONSTRUCTION OF WELL



MW 3-3

CONSTRUCTION OF WELL



MW 3-3

TEST BORING LOG

Project Lake City AAP

Boring No. **MW 3-3** Sheet **1** of **1**

Surface Elevation 742.2 Offset

Date Started 8/14/81 Completed 8/14/81

County & State Independence, Missouri

Driller **T. Butler** Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**MARKS: (Casing, Water Loss, Etc.)**

umped 1 hour - 1/2 GPM

STATIC Water Level

Time

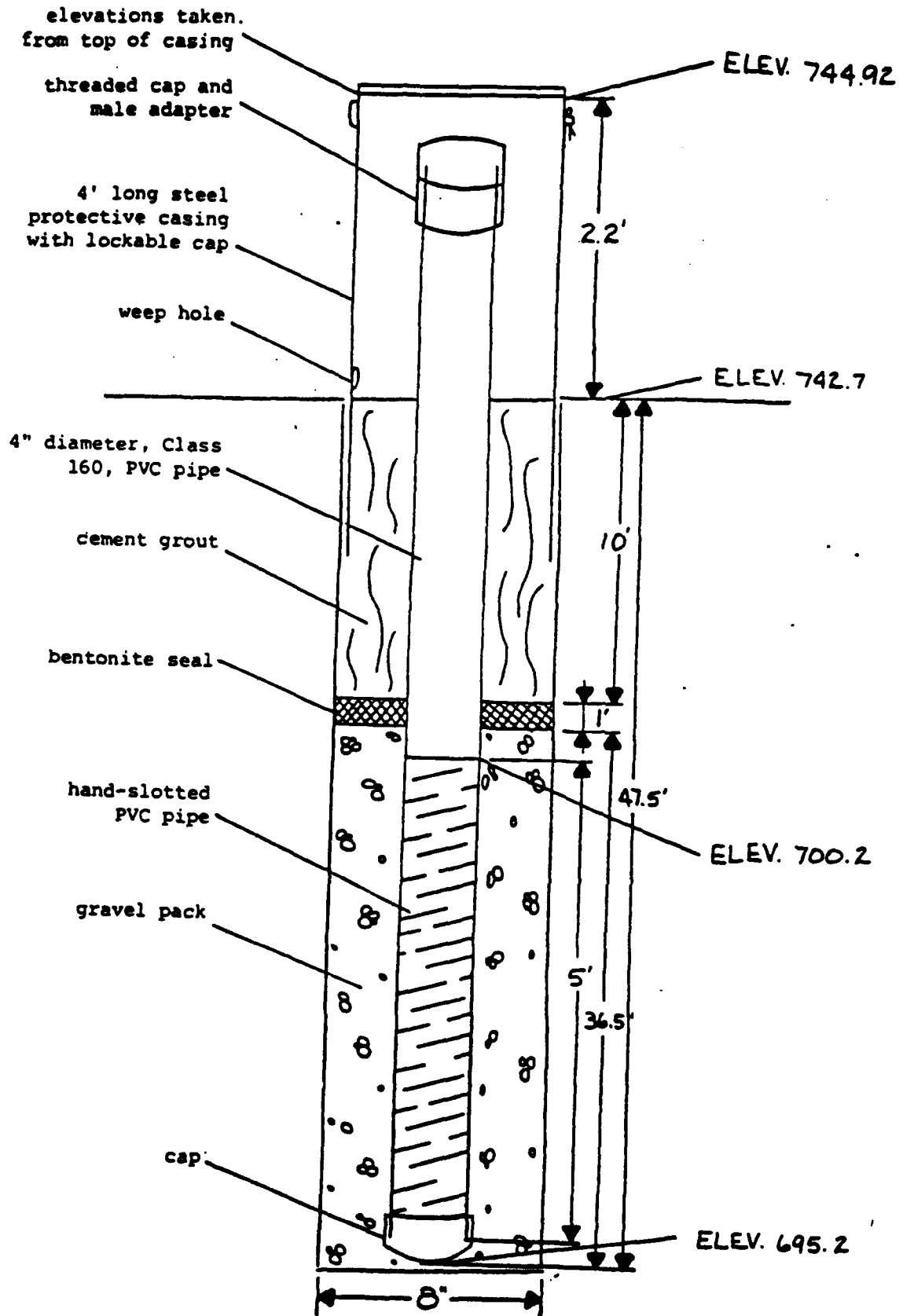
Date

16.1

9/10/81 (Completion)

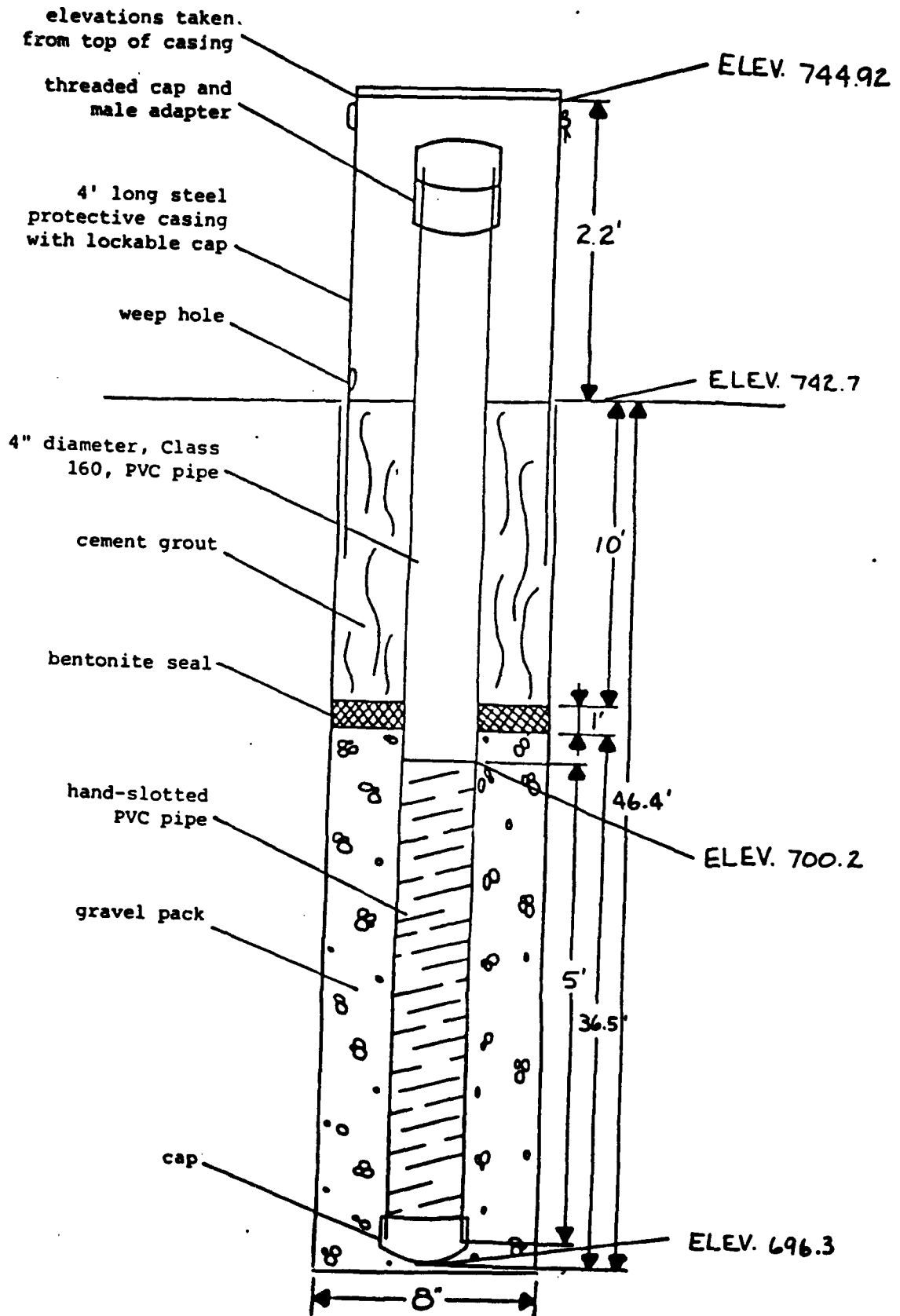
Gayne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 3-4

CONSTRUCTION OF WELL



NY 3-4

TEST BORING LOG

Project Lake City AAP

Boring No. MW 3-4 Sheet 1 of 1

Surface Elevation 742.7 Offset _____

Address _____

Date Started 9/22/81 Completed 9/22/81

City & State Independence, Missouri

Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Brown silty clay, stiff
5.0'	10.0'	WB				Gray & brown clayey silt, med.
10.0'	11.6'	WB				Same
11.6'	15.0'	WB				Brown sandy silt, med.
15.0'	20.0'	WB				Same
20.0'	26.4'	WB				Same
26.4'	30.0'	WB				Brown & gray sandy silt, very stiff
30.0'	33.0'	WB				Same
33.0'	35.0'	WB				Gray fine sand, loose
35.0'	40.0'	WB				Same
40.0'	45.0'	WB				Gray fine sand w/trace med. sand, loose
45.0'	50.0'	WB				Same
50.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

amped 1.75 hours - 7 GPM

Static
Water Level

27.8

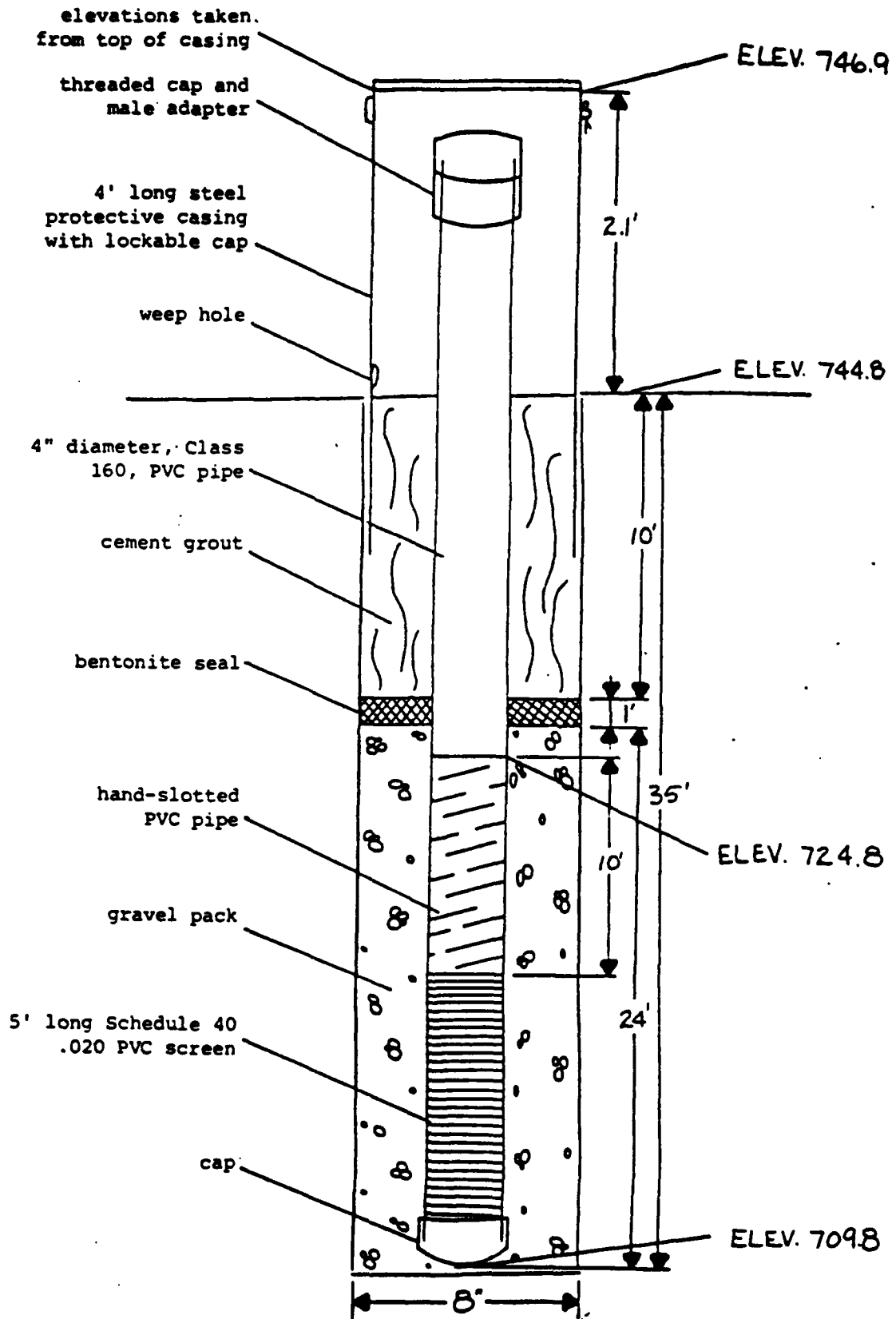
Time

Date

9/22/81 (Completion)

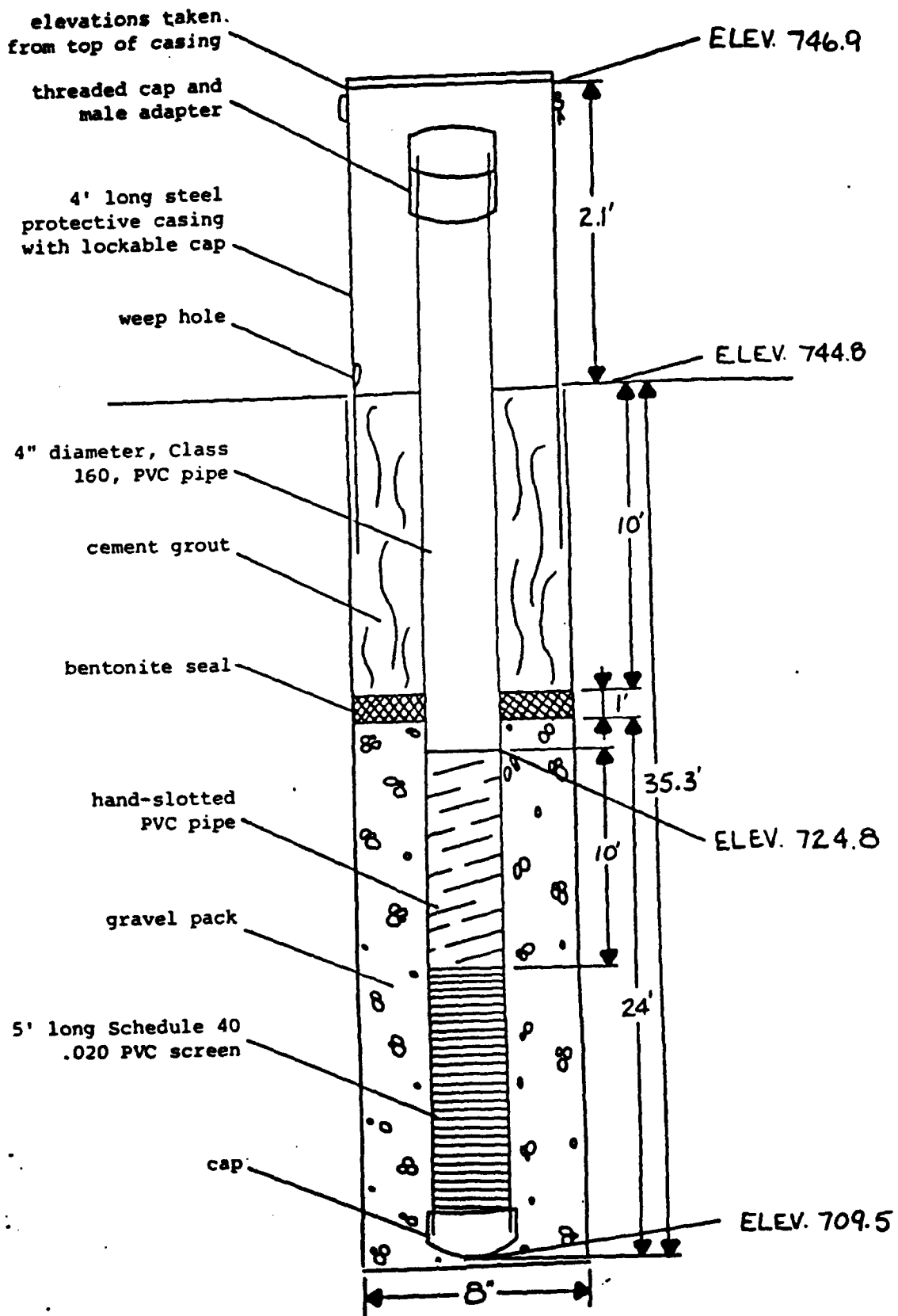
Western Company, Inc.

CONSTRUCTION OF WELL



MW 3-5

CONSTRUCTION OF WELL



MW 3-5

TEST BORING LOG

Object Lake City AAP

Boring No. MW 3-5 Sheet 1 of 1

Surface Elevation 744.8 Offset _____

Address _____

Date Started 8/13/81 Completed 8/14/81

City & State Independence, Missouri

Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Brown silty clay, very stiff
5.0'	9.5'	WB				Dark brown clayey sand, med. dense
9.5'	11.0'	SS1		3-5-5	1.4'	Same
11.0'	13.0'	WB				Same
13.0'	15.0'	WB				Gray & brown silty clay w/trace sand, very stiff
15.0'	20.0'	WB				Same
20.0'	25.0'	WB				Same
25.0'	28.0'	WB				Brown silty sand w/trace clay, med. dense
28.0'	29.5'	WB				Same
29.5'	31.0'	SS2		3-5-5	1.4'	Same
31.0'	32.0'	WB				Same
32.0'	35.0'	WB				Blue gray sandy silt, very stiff
35.0'	40.0'	WB				Same
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

umped 1-1/2 hour - 2 GPM

Static Water Level

30.4

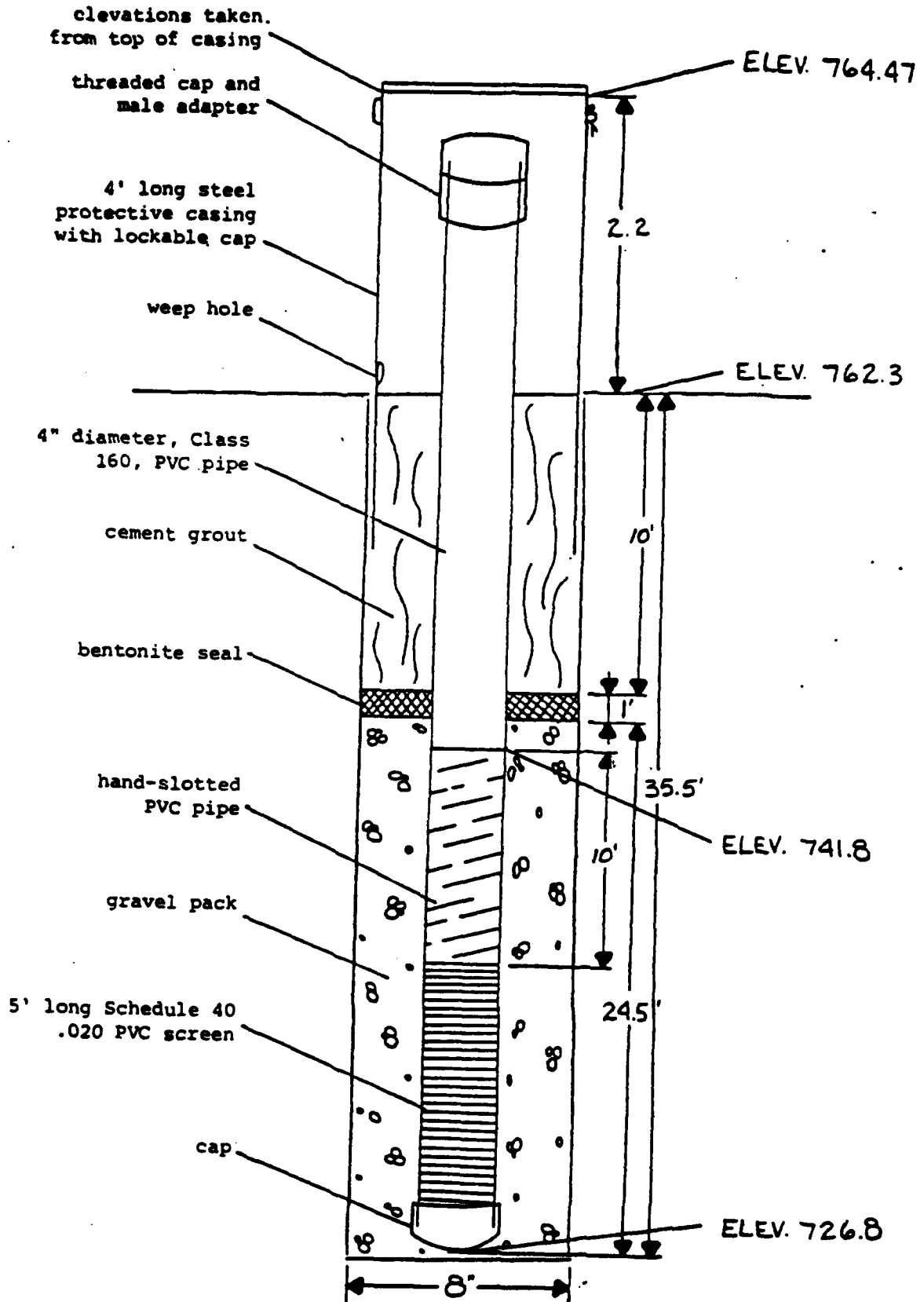
Time

Date

9/10/81 (Completion)

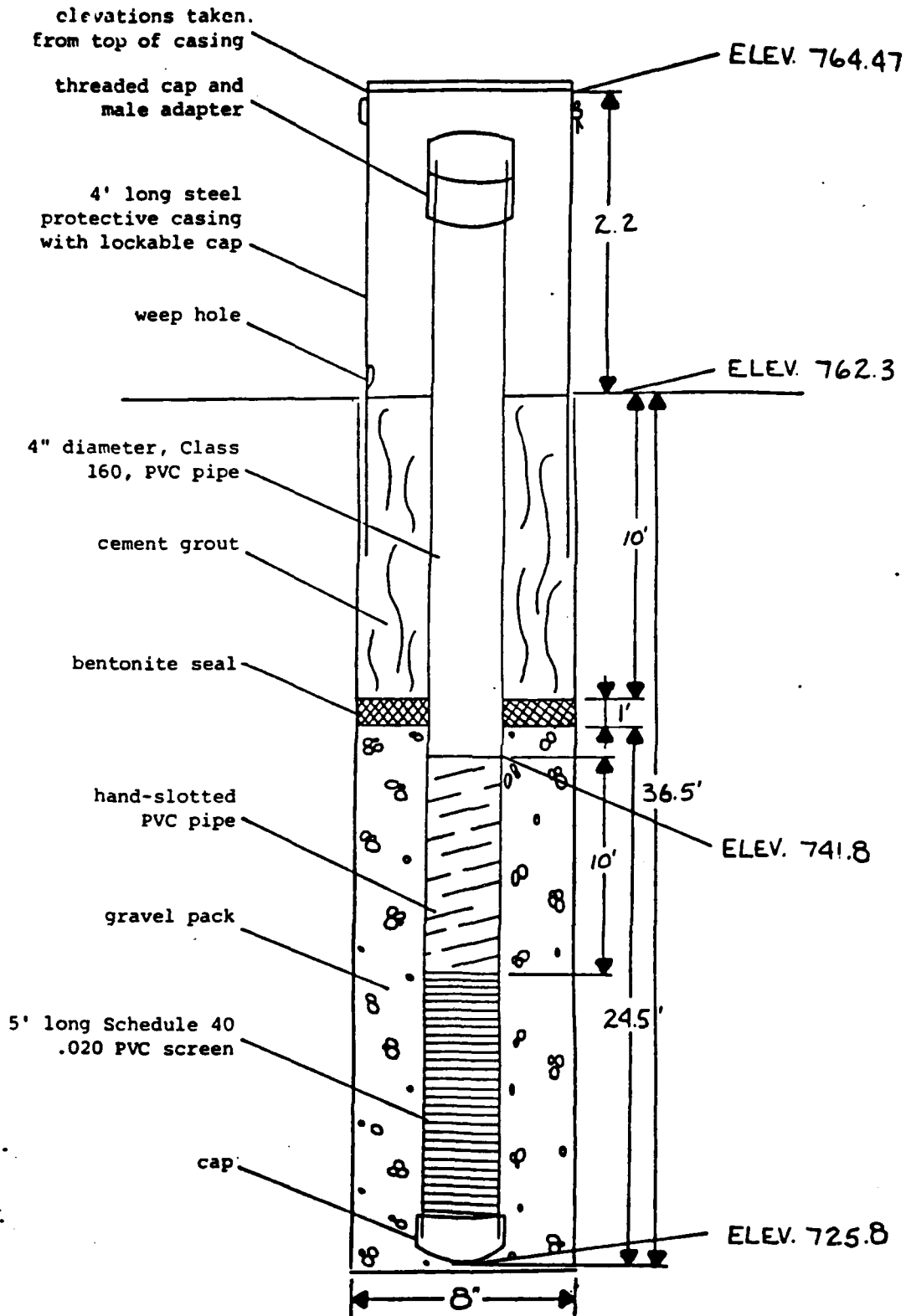
Wayne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 4-1

CONSTRUCTION OF WELL



MW 4-1

TEST BORING LOG

Project Lake City AAP

Boring No. MW 4-1 Sheet 1 of 1

Surface Elevation 762.3 Offset _____

Date Started 8/11/81 Completed 8/12/81

City & State Independence, Missouri

Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Gray & brown silty clay, very stiff
5.0'	9.5'	WB				Same
9.5'	11.0'	ST1	2.5		1.0'	Same
11.0'	15.0'	WB				Same
15.0'	20.0'	WB				Gray & brown silty clay w/trace sand & gravel, very stiff
20.0'	25.0'	WB				Same
25.0'	30.0'	WB				Same
30.0'	35.0'	WB				Same
35.0'	36.0'	WB				Same
36.0'	40.0'	WB				Yellow brown silty clay w/trace sand, very stiff
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date

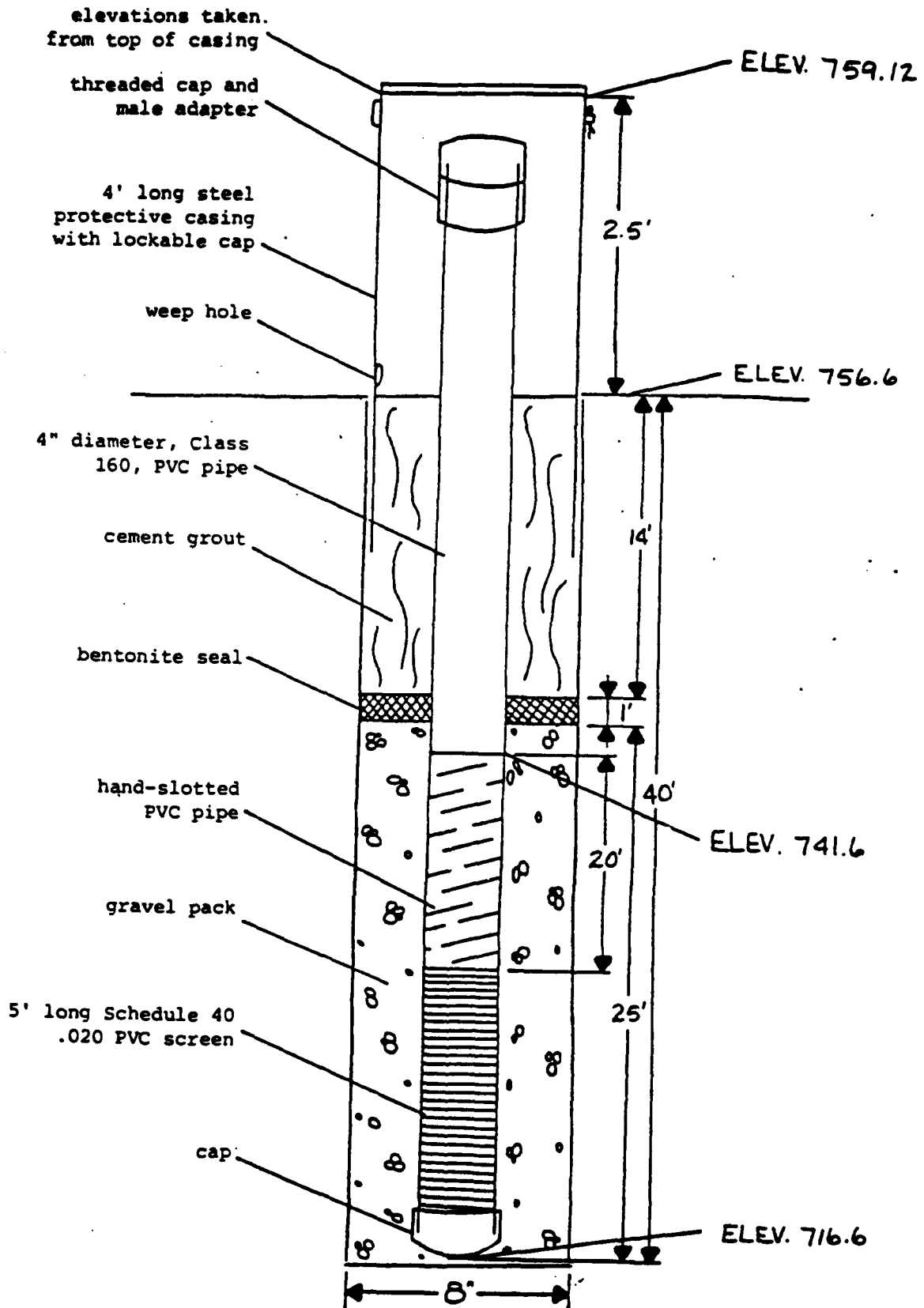
Pumped 2 hours - 1/2 GPM

18.9

9/11/81 (Completion)

Wynne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 4-2

TEST BORING LOG

Project Lake City AAP

Boring No. MW 4-2 Sheet 1 of 1

Surface Elevation 756.6 Offset

Date Started 8/24/81 Completed 8/25/81

City & State Independence, Missouri

Driller T. Butler Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETROMETER	NO. OF BLOWS		
0.0'	0.5'	WB				Topsoil
0.5'	7.0'	WB				Dark brown silty clay, soft
7.0'	9.5'	WB				Gray silty clay, soft
9.5'	11.0'	ST1	1.0			Gray clayey silt, soft
11.0'	16.0'	WB				Same
16.0'	19.5'	WB				Light tan silty clay, soft
19.5'	21.0'	ST2	2.0			Gray silty clay w/trace sand, soft to med.
21.0'	29.5'	WB				Gray sandy clay, soft to med.
29.5'	39.5'	WB				Same
39.5'	41.0'	SS1				Same
41.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

STATIC Water Level

Time

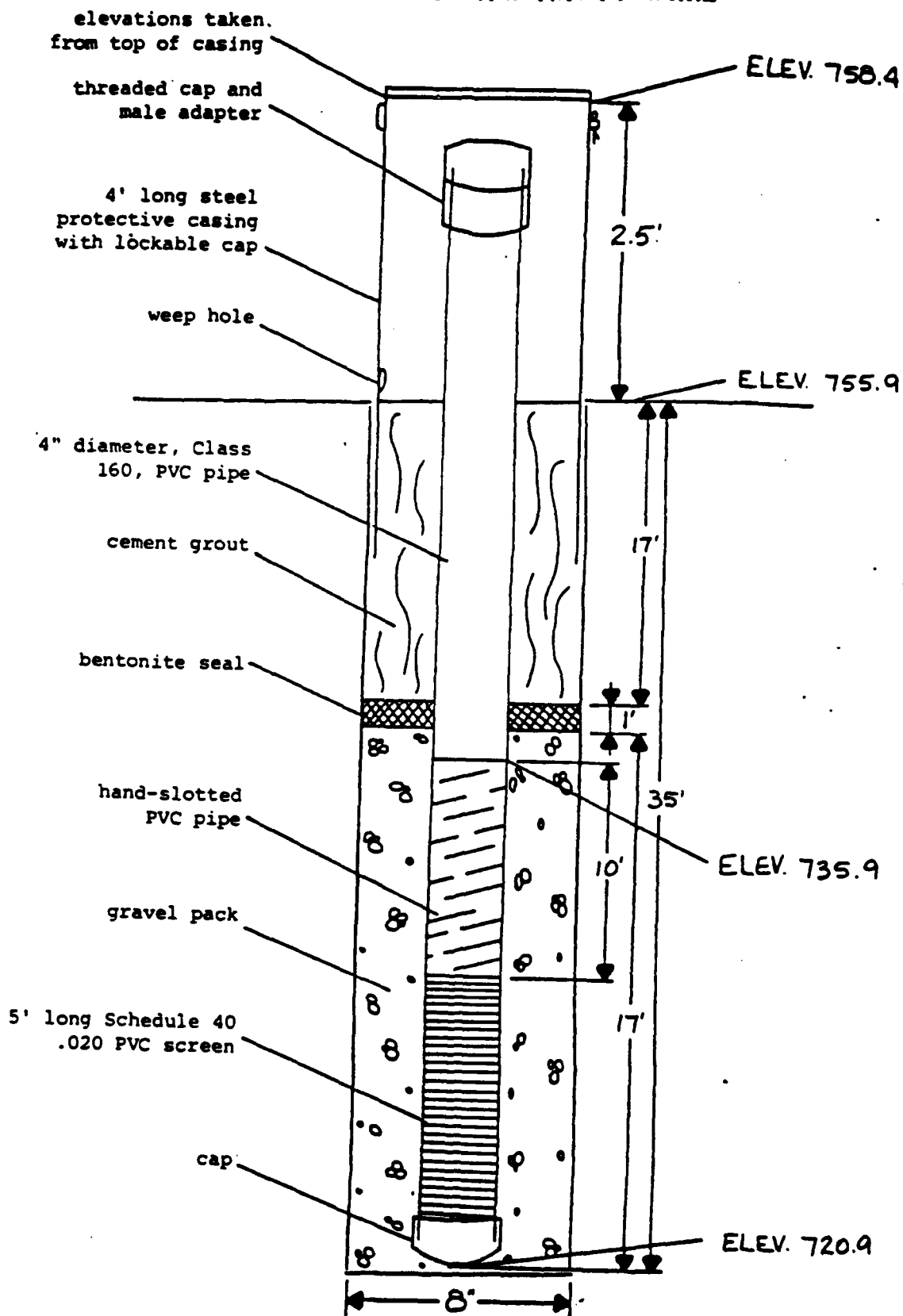
Date

mped 2 hours - 1/2 GPM

10.0

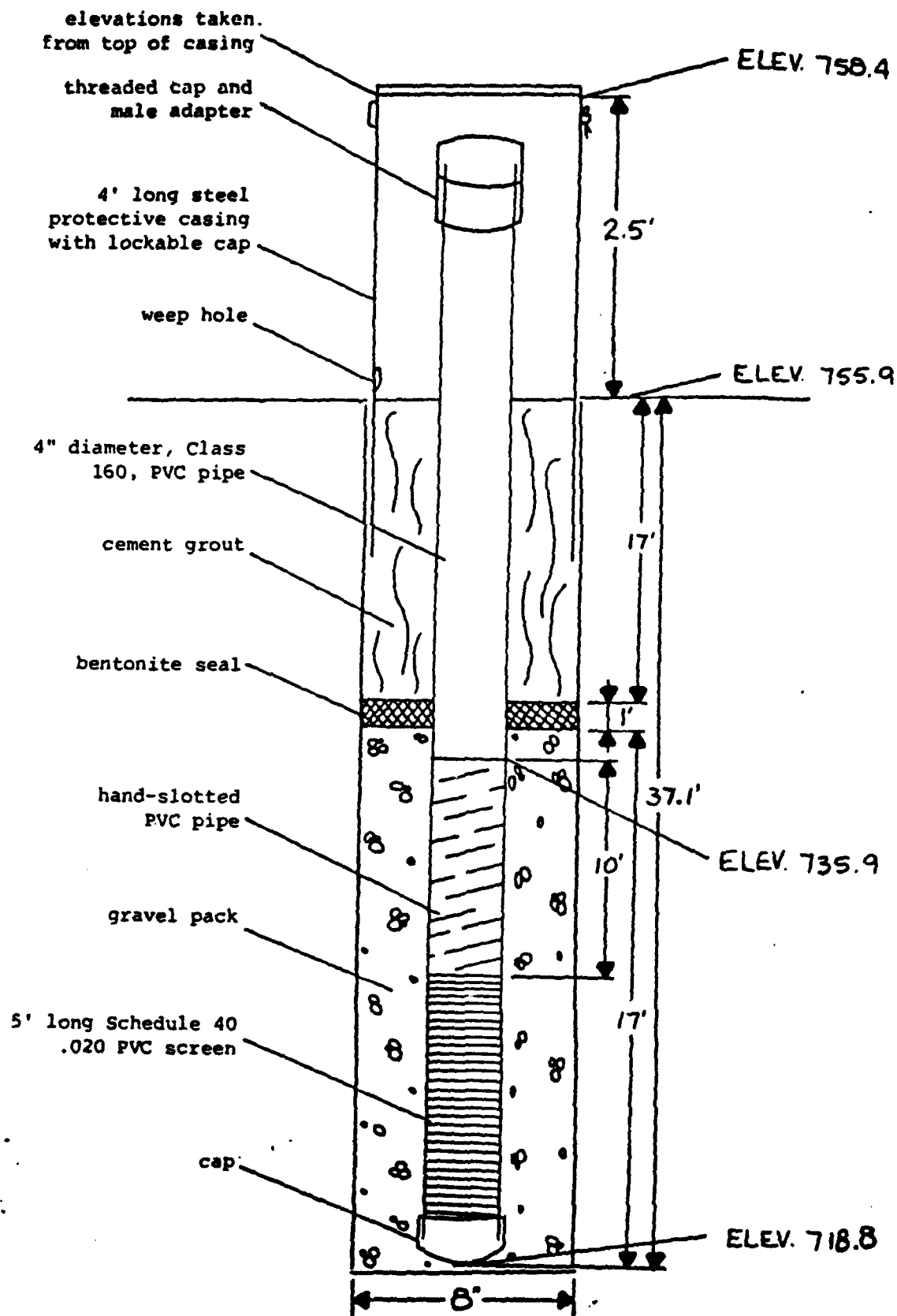
9/11/81(Completion)

CONSTRUCTION OF WELL



MW 4-3

CONSTRUCTION OF WELL



MW 4-3

TEST BORING LOG

Project Lake City AAP

Boring No. MW 4-3 Sheet 1 of 1

Surface Elevation 755.9 Offset _____

Address _____

Date Started 8/12/81 Completed 8/12/81

City & State Independence, Missouri

Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	7.5'	WB				Dark brown silty clay, soft to med.
7.5'	9.5'	WB				Brown silty clay, med. to stiff
9.5'	11.0'	ST1	4.5			Brown silty clay, very stiff
11.0'	12.5'	WB				Brown silty clay, stiff
12.5'	17.0'	WB				Light gray silty clay, soft to med.
17.0'	19.5'	WB				Light brown silty clay, soft to med.
19.5'	21.0'	ST2	1.0			Light gray silty sandy clay, med.
21.0'	23.0'	WB				Light gray silty sandy clay, soft to med.
23.0'	28.0'	WB				Light gray silty clay w/trace sand, soft to med.
28.0'	33.5'	WB				Light gray silty clay w/trace sand, soft to med.
33.5'	34.5'	WB				Light gray silty clay w/trace sand & weathered shale, soft to med.
34.5'	40.0'	WB				Light brown sandy clay, soft to med.
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date

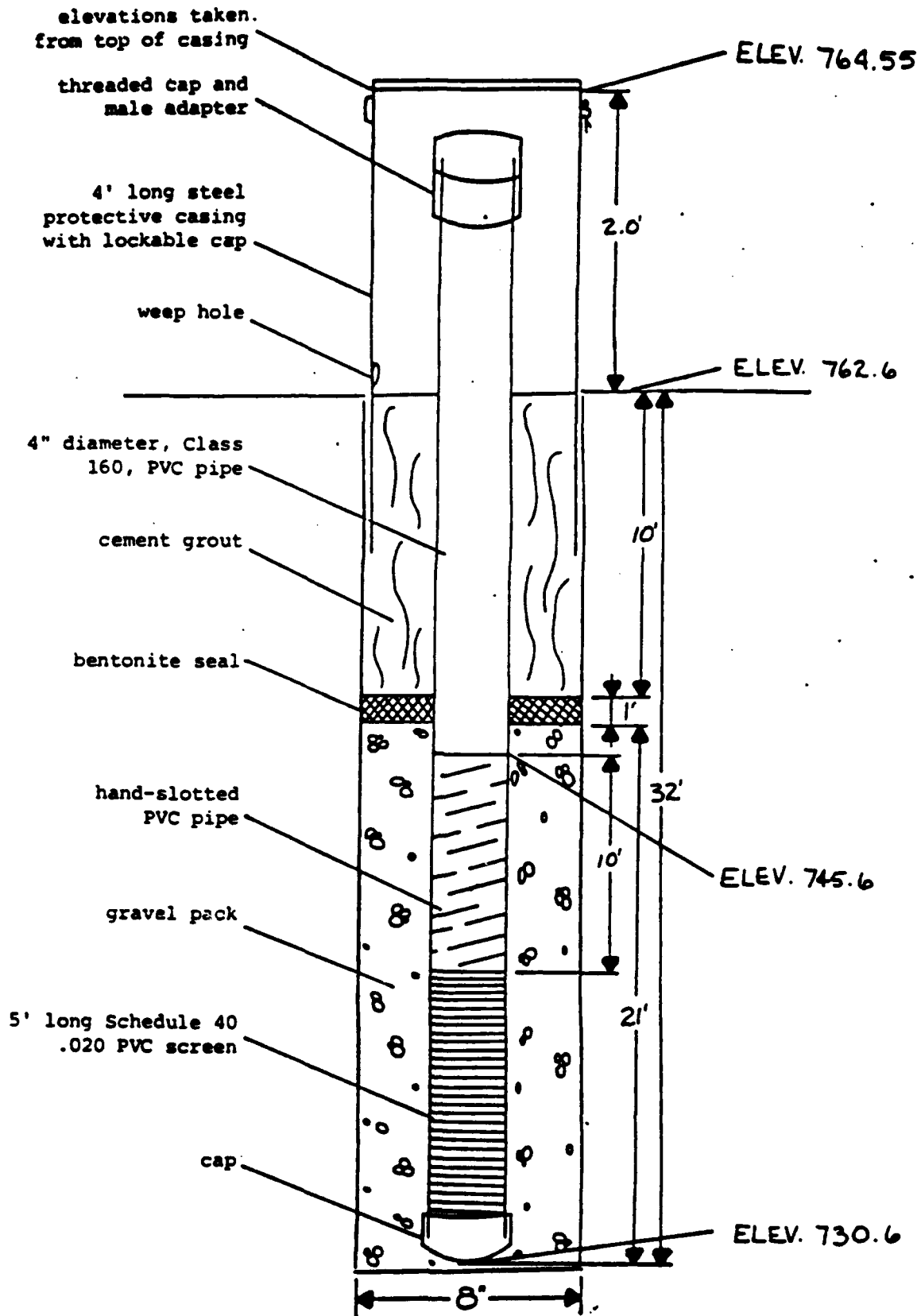
Pumped 1-1/2 hour - 1 GPM

8.0

9/11/81 (Completion)

Byrne-Western Company, Inc.

CONSTRUCTION OF WELL



MW 4-4

TEST BORING LOG

Project Lake City AAP Boring No. MW 4-4 Sheet 1 of 1
 Address Independence, Missouri Surface Elevation 762.6 Offset
 City & State Independence, Missouri Date Started 8/12/81 Completed 8/13/81
 Driller B. Blank Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO. METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Gray & brown silty clay, very stiff
5.0'	10.0'	WB				Same
10.0'	15.0'	WB				Same
15.0'	19.0'	WB				Same
19.0'	20.5'	ST1	1.5		1.3'	Gray & brown silty clay w/trace sand, stiff
20.5'	25.0'	WB				Same
25.0'	30.0'	WB				Brown & gray silty clay w/trace sand & gravel, very stiff
30.0'	35.0'	WB				Same
35.0'	36.0'	WB				Same
36.0'	40.0'	WB				Brown silty clay, very stiff
40.0'	Total	depth				

MARKS: (Casing, Water Loss, Etc.)

Pumped 2 hours - 1/2 GPM

Static
Water Level

Time

Date

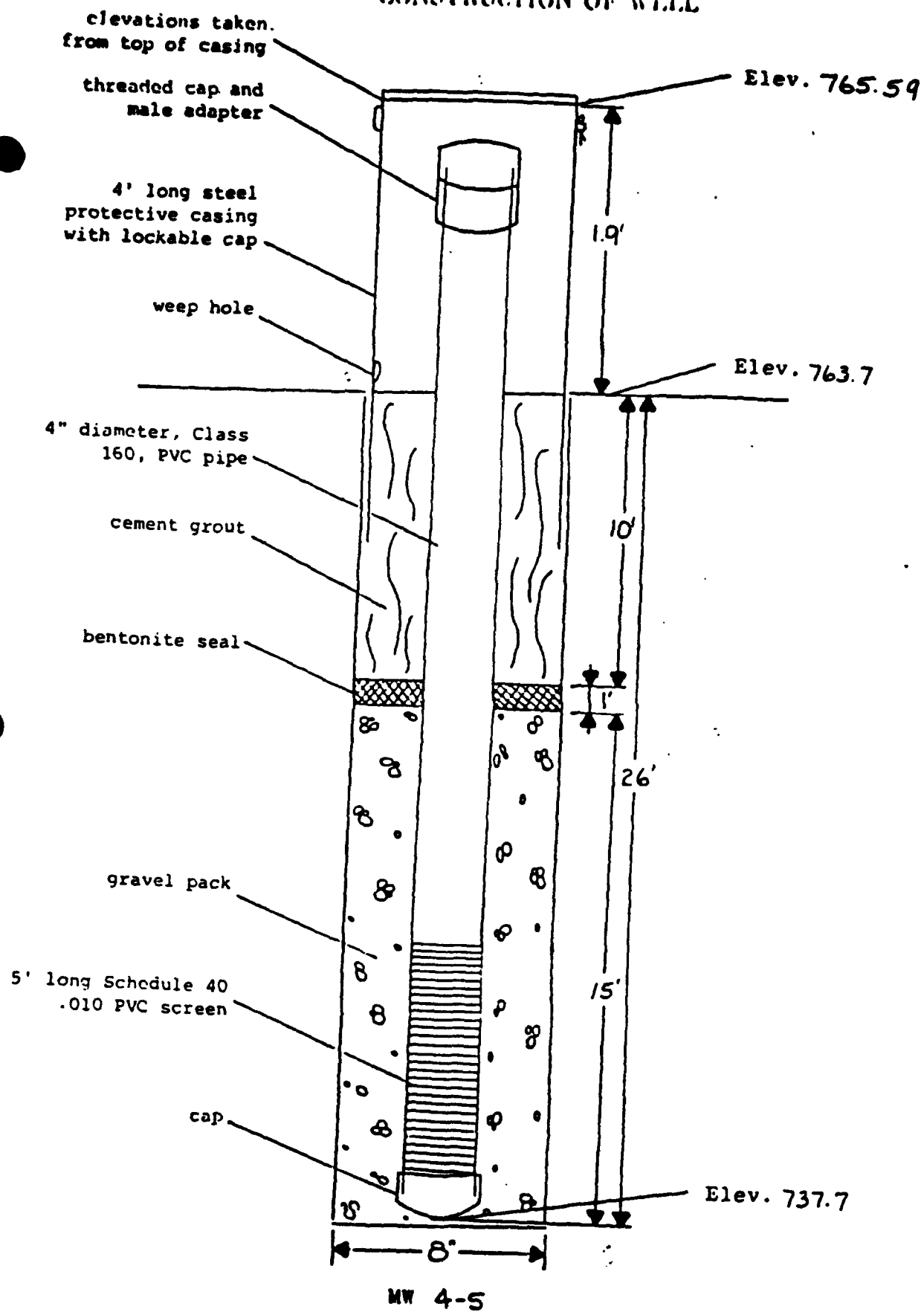
13.8

9/11/81(Completion)

Pyne-Western Company, Inc.

C-201

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 4-5 Sheet 1 of 1

Surface Elevation _____ Offset _____

Ad _____

Date Started 1/21/82 Completed 1/21/82

City & State Independence, Missouri

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

ARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

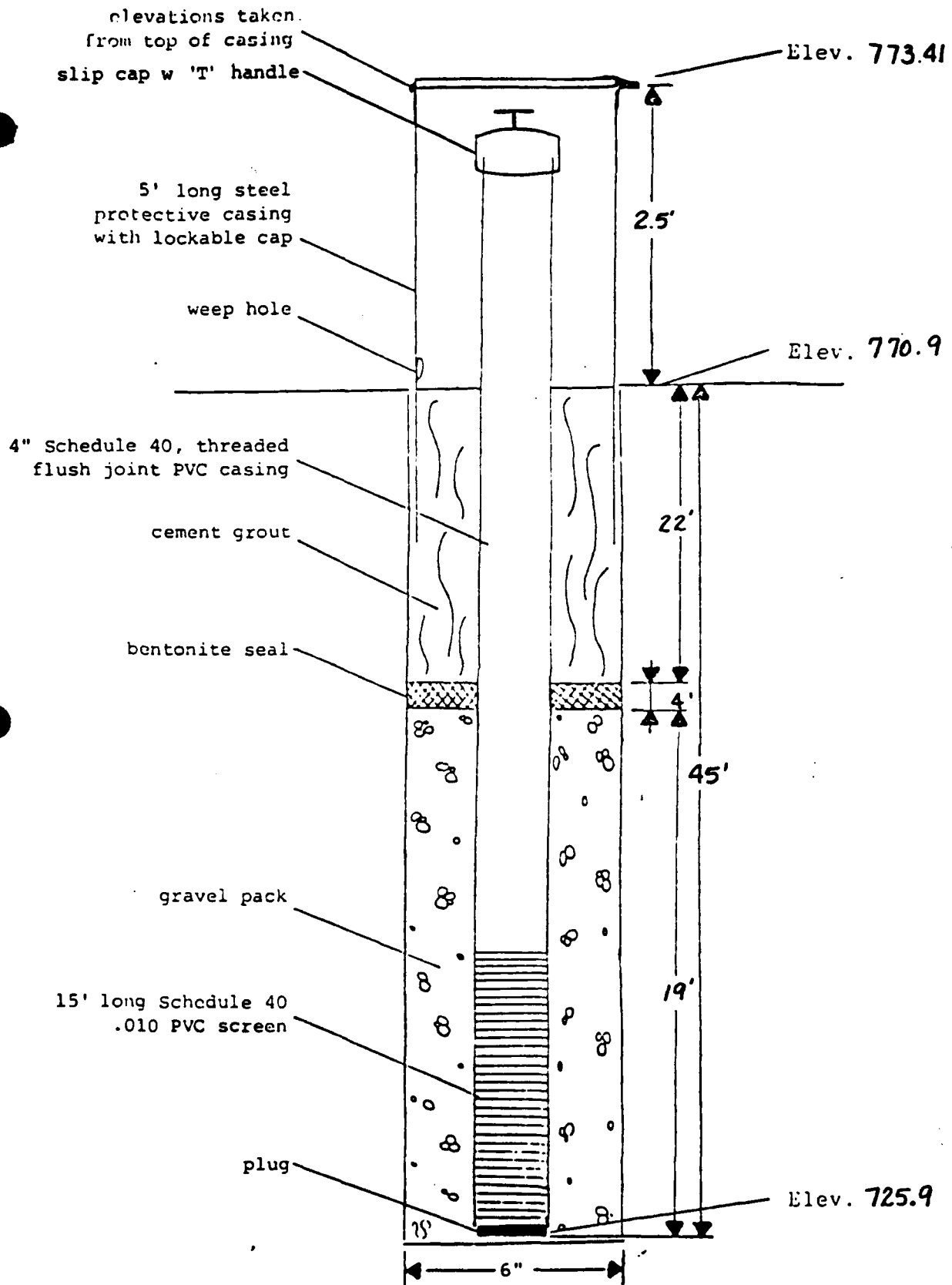
Pumped 2 1/2 hours @ 3.5 GPM, not steadily

4.0'

Before Pumping

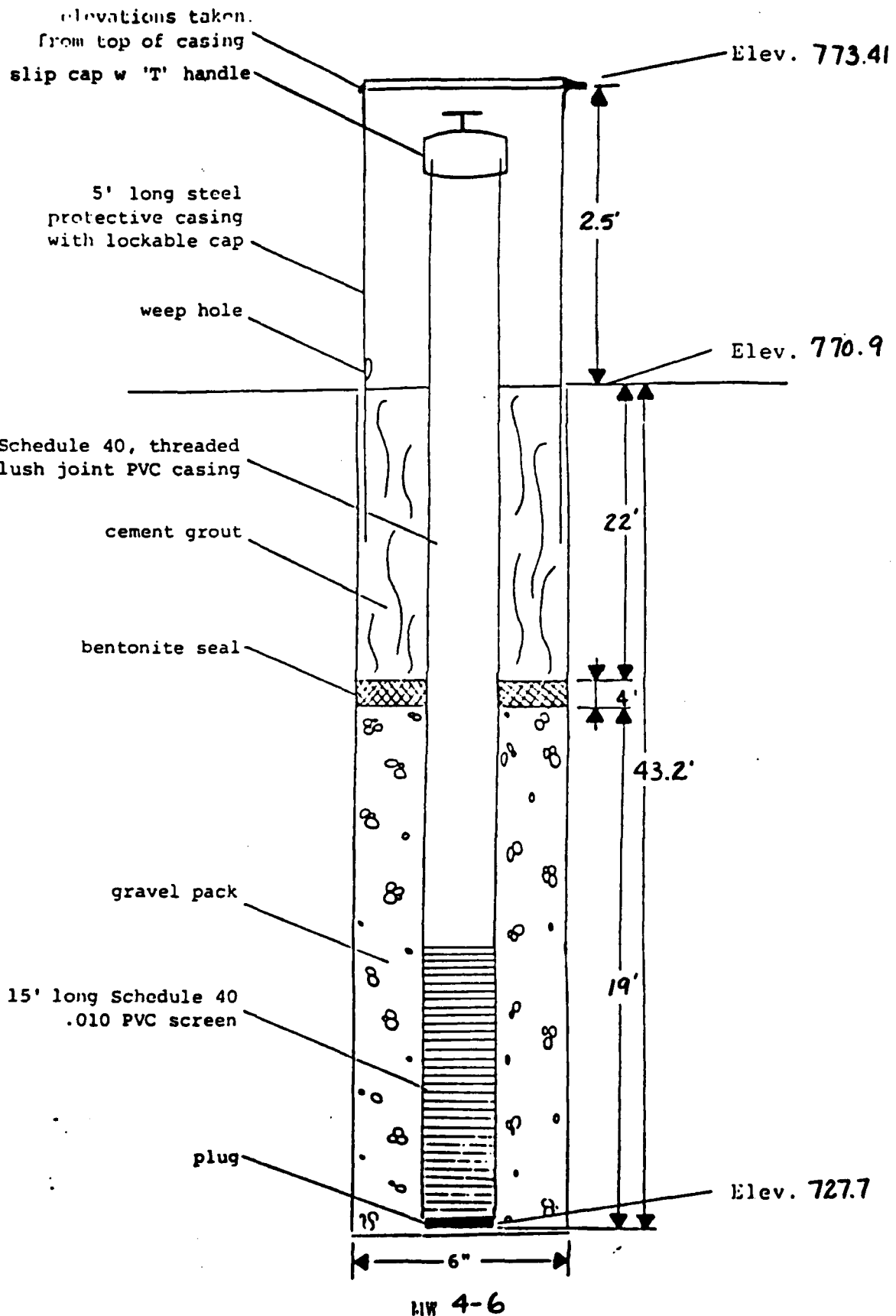
1/25/82 (Completion)

WELL CONSTRUCTION



MW 4-6

WELL CONSTRUCTION



TEST BORING LOG

Project Lake City Army Ammunition Plant Boring No. TH 1 Sheet 1 of 2
 Address Lake City Plant Surface Elevation 761.5 Offset _____
 City & State Independence, Missouri Date Started 9/26/83 Completed 9/26/83
 Driller M. L. Blank Rig D-12

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	HA				Brown silty clay, moist, very stiff
1.0'	2.5'	SS1		5-7-10	0.3'	Brown & dark brown gray silty clay, fill, iron stains, moist, very stiff
2.5'	4.0'	SS2		6-6-6	1.5'	Gray & brown silty clay w/iron stains, trace of roots & small rock, fill, moist, stiff
4.0'	5.5'	SS3		6-7-10	1.5'	Gray & brown very silty clay, w/iron stains, trace small rock, moist, very stiff
5.5'	7.0'	SS4		3-6-7	1.5'	Gray very silty clay w/iron stains, moist, stiff
7.0'	8.5'	SS5		4-6-10	1.5'	Same
8.5'	10.0'	SS6		3-6-8	1.5'	Same
10.0'	11.5'	SS7		3-6-9	1.5'	Gray w/brown silty clay, w/iron stains, moist, stiff (possible fill)
11.5'	13.0'	SS8		3-5-5	1.5'	Gray very silty clay w/ iron stains, moist, stiff (increasing moisture content)
13.0'	14.5'	SS9		2-4-6	1.5'	Same
14.5'	16.0'	SS10		2-4-4	1.5'	Gray fine sandy silty clay, w/trace iron stain & small rock, moist, medium (possible fill?)
16.0'	17.5'	SS11		2-4-6	1.5'	Gray very silty clay, trace fine sand & small rock, moist, stiff, (possible fill?)
17.5'	19.0'	SS12		2-5-6	1.5'	Gray w/trace brown very silty clay, trace iron stains, moist, stiff (possible fill?)
19.0'	20.5'	SS13		3-4-6	1.5'	Gray w/trace brown very silty clay, becoming sandier w/depth, moist, stiff
20.5'	22.0'	SS14		2-4-5	1.5'	Gray w/trace brown silt, traces of fine sand & clay, moist, stiff
22.0'	23.5'	SS15		3-3-5	1.5'	Gray w/trace brown clayey silt, trace iron stains, moist, medium

MARKS: (Casing, Water Loss, Etc.)

Water Level Time Date

(Completion)

TEST BORING LOG

Project Lake City Army Ammunition Plant Boring No. TH 1 Sheet 2 of 2
 Surface Elevation _____ Offset _____
 Date Started _____ Completed _____
 Driller _____ Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
23.5'	25.0'	SS16		4-5-7	1.5'	Gray w/trace brown silt, w/traces of clay, moist, stiff
25.0'	26.5'	SS17		3-4-5	1.5'	Gray silt, w/traces of clay in upper zone, very moist, (increasing moisture w/depth), stiff
26.5'	28.0'	SS18		2-3-6	1.5'	Gray clayey silt, moist, stiff
28.0'	29.5'	SS19		3-4-4	1.5'	Gray clayey silt, trace fine sand, wet pockets in soil, very moist, medium
29.5'	31.0'	SS20		4-6-7	1.5'	Gray clayey silt, w/rocky zones (chert) limestone, very moist, stiff
31.0'	32.5'	SS21		2-4-5	1.5'	Gray silt, trace of clay & fine sand, moist, stiff
32.5'	34.0'	SS22		5-6-6	1.5'	Brown gray clayey silt, w/traces fine sand, moist, stiff (sampler wet)
34.0'	35.5'	SS23		4-5-6	1.5'	Brown gray clayey silt, trace fine sand, iron nodules & stains, moist, stiff
35.5'	37.0'	SS24		2-4-6	1.5'	Gray clayey silt, w/iron stains & nodules, w/traces of rock, moist, stiff
37.0'	38.5'	SS25		4-5-7	1.5'	Brown clayey silt w/traces of rock, moist, stiff
38.5'	40.0'	SS26		3-5-6	1.5'	Brown w/traces of gray clayey silt, moist, stiff
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

(Completion)

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. TH 2 & MW-4-6

Sheet 1 of 3

Surface Elevation 770.9 Offset _____

Address Lake City Plant

Date Started 9/27/83 Completed 9/27/83

City & State Independence, Missouri

Driller M. L. Blank

Rig D-12

Abbreviations:

A.O. - Auger Only
H.A. - Hollow Auger
W.B. - Wash Bore

R.B. - Rock Bit
S.S. - Split Spoon
S.T. - Shelby Tube

C.W. - Core Water
C.A. - Core Air
F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO. METER	NO. OF BLOWS		
0.0'	1.0'	HA				Topsoil
1.0'	2.5'	SS1		5-5-5	0.5'	Gray brown clayey silt, trace of roots, slightly moist, stiff
2.5'	4.0'	SS2		6-4-3	0.5'	Gray brown clayey silt, trace of roots, slightly moist, medium
4.0'	5.5'	SS3		2-2-4	0.8'	Gray & brown very silty clay, trace of dark & iron stains, moist, medium (fill)
5.5'	7.0'	SS4		6-4-6	1.5'	Gray & brown very silty clay, trace of dark & iron stains, moist, stiff (fill)
7.0'	8.5'	SS5		2-4-5	1.5'	Gray w/brown very silty clay w/gray clay pocke trace of roots, moist, stiff (fill)
8.5'	10.0'	SS6		2-4-6	1.5'	Gray w/brown very silty clay w/gray clay pocke w/dark nodules, moist, stiff (fill)
10.0'	11.5'	SS7		3-4-7	1.5'	Same
11.5'	13.0'	SS8		4-6-8	1.5'	Brown w/gray very silty clay, trace of dark nodules, moist, stiff (fill?)
13.0'	14.5'	SS9		2-5-6	1.5'	Brown & gray very silty clay, tr. of dark nodul & iron stains, moist, stiff
14.5'	16.0'	SS10		2-4-6	1.5'	Brown & gray very silty clay, tr. of dark nodule & iron stains, sand & small rock, moist, stiff
16.0'	17.5'	SS11		3-4-6	1.5'	Same
17.5'	18.5'	SS12		1-7-9	1.5'	Gray very silty clay, traces of dark nodules, fine sand & small rock, moist, very stiff
18.5'	20.0'	SS13		2-10-14	1.5'	Gray very silty clay, traces of dark nodules, & iron stains, moist, very stiff
20.0'	21.5'	SS14		4-7-10	1.5'	Same
21.5'	23.0'	SS15		4-8-12	1.5'	Gray & brown very silty clay, dark & iron stains, moist, very stiff

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

w/augers in

28.3'

2:15 pm

9/27/83 (Completion)

20.5'

10:00 am

9/28/83

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. TH 2 & MW-4-6 Sheet 2 of 3

Surface Elevation _____ Offset _____

Address _____

Date Started _____ Completed _____

City & State _____

Driller _____ Rig _____

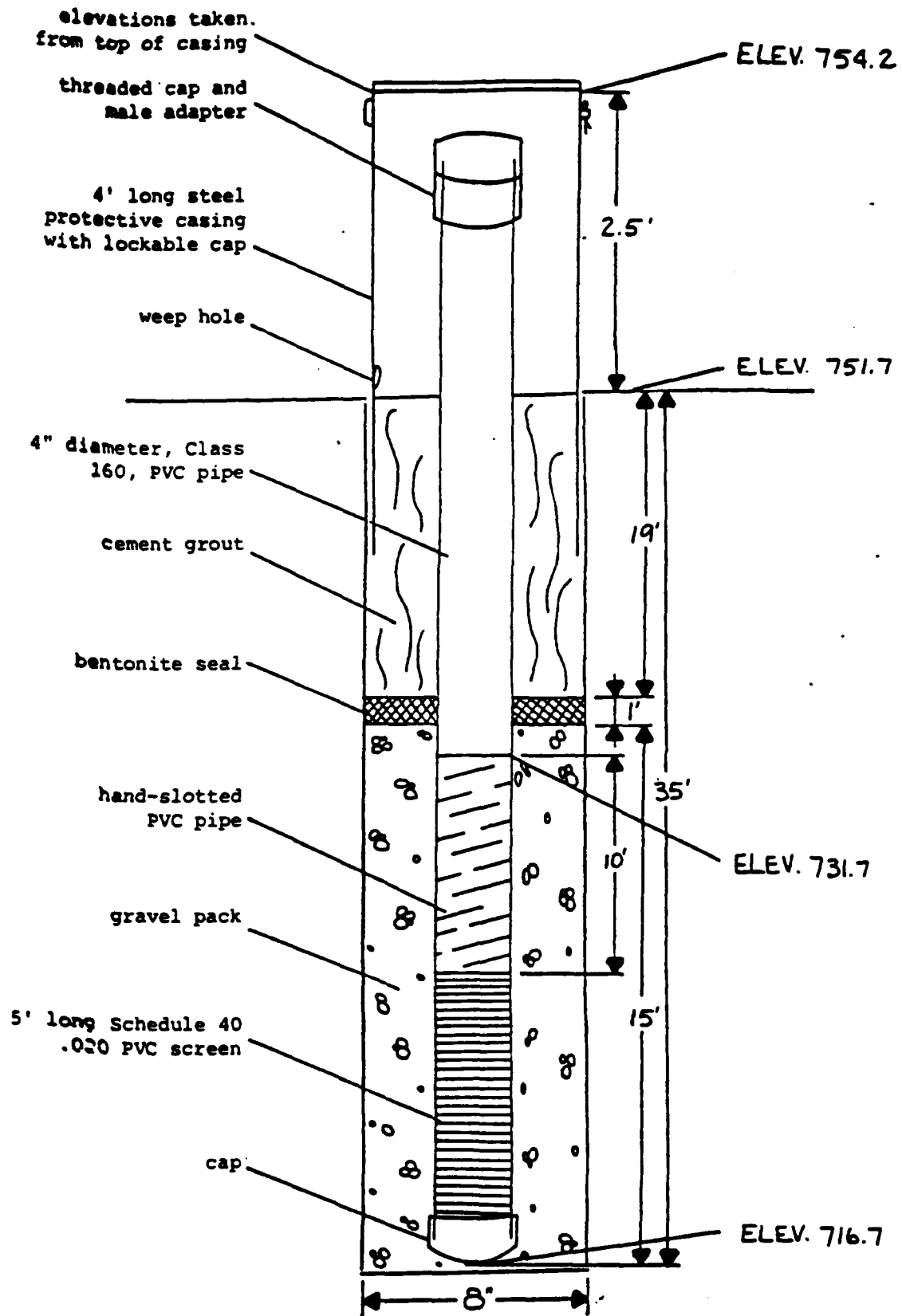
Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETROMETER	NO. OF BLOWS		
23.0'	24.5'	SS16		5-8-11	1.5'	Gray & brown very silty clay, dark & iron stains, moist, very stiff
24.5'	26.0'	SS17		4-7-8	1.5'	Same (sample gets grayer w/depth)
26.0'	27.5'	SS18		3-6-10	1.5'	Brown & gray very silty clay, traces of iron & dark stains, moist, stiff
27.5'	29.0'	SS19		4-8-12	1.5'	Brown & gray very silty clay w/dark stains, traces of iron stains, moist, stiff
29.0'	30.5'	SS20		5-8-12	1.5'	Brown & gray very silty clay, traces of small rock & iron nodules, moist, very stiff
30.5'	32.0'	SS21		4-8-12	1.5'	Brown & blue gray very clayey silt w/dark stains, moist, very stiff
32.0'	33.0'	HA				Same
33.0'	34.5'	SS22		4-7-11	1.5'	Brown & gray clayey silt w/dark & iron stains, moist, very stiff
34.5'	36.0'	SS23		4-6-9	1.5'	Brown & gray clayey silt w/dark & iron stains w/traces of small rock, moist, very stiff
36.0'	37.5'	SS24		2-5-8	1.5'	Same
37.5'	39.0'	SS25		5-6-10	1.5'	Brown & gray clayey silt w/dark & iron stains w/traces small rock & fine sand, moist, v. st.
39.0'	40.5'	SS26		5-6-10	1.5'	Same
40.5'	42.0'	SS27		6-8-11	1.5'	Same (Note: rock is concentrated in zones in sample & is mostly chert)
42.0'	43.5'	SS28		3-7-9	1.5'	Brown & gray sandy clayey silt, w/dark & iron stains, traces of small rock, moist, very stiff (water on sampler)
43.5'	45.0'	SS29		4-7-8	1.5'	Brown & gray sandyclayey silt w/dark & iron stains, w/lots of rock & sandy zones, moist, very stiff

MARKS: (Casing, Water Loss, Etc.)

Water Level _____ Time _____ Date _____
(Completion)

CONSTRUCTION OF WELL



MW 5-1

TEST BORING LOG

Project Lake City AAP

Boring No. MW 5-1 Sheet 1 of 1

Surface Elevation 751.7 Offset _____

Ad. _____

Date Started 8/10/81 Completed 8/10/81

& State Independence, Missouri

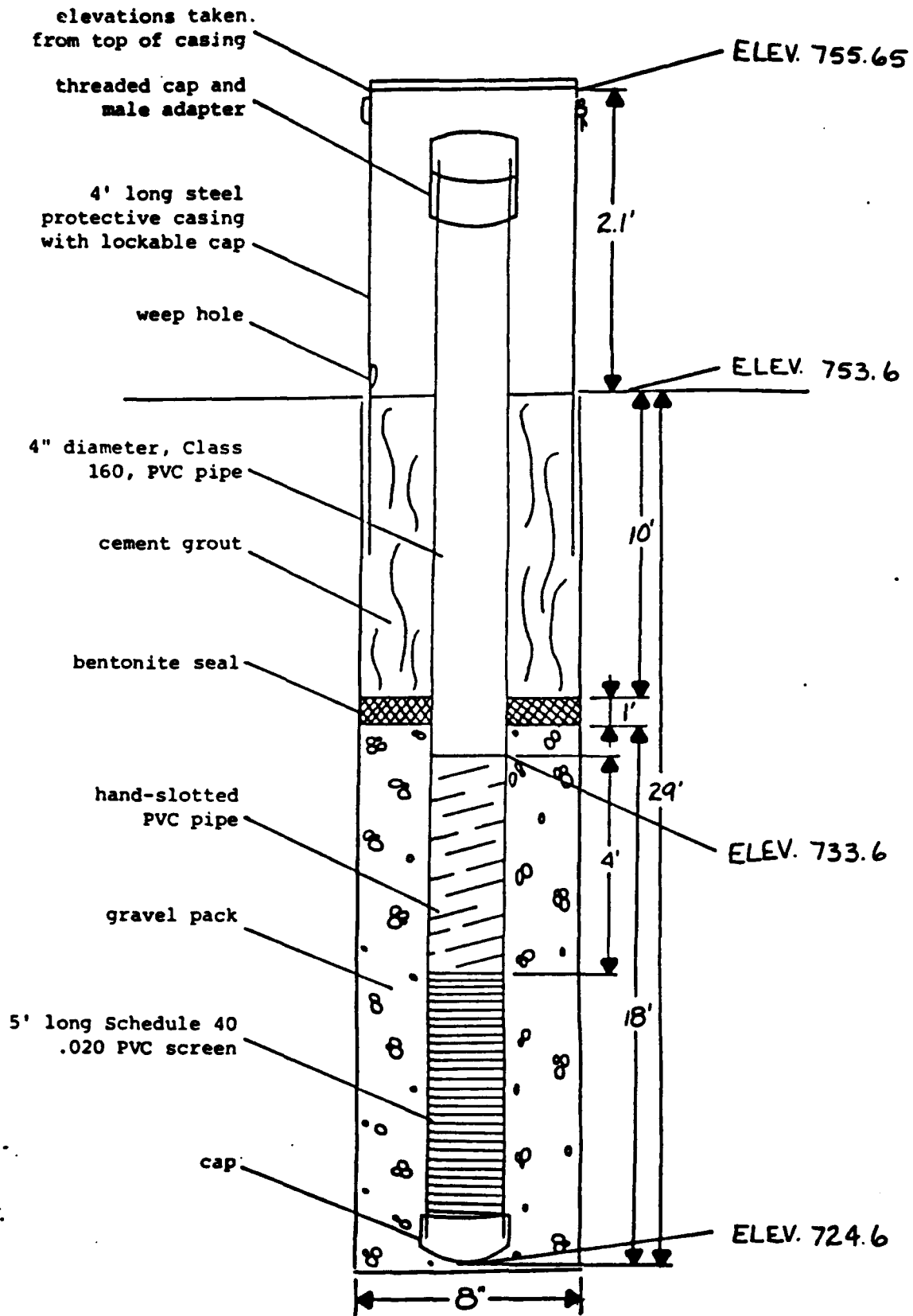
Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO. METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.5'	WB				Light brown silty clay, med.
5.5'	9.5'	WB				Gray silty clay, med.
9.5'	11.0'	ST1	2.0			Gray silty clay w/trace sand, stiff
11.0'	15.0'	WB				Gray silty clay w/trace sand, med.
15.0'	19.5'	WB				Light brown silty clay w/trace sand
19.5'	21.0'	ST2	2.5			Light brown & gray silty clay, very sti
21.0'	23.5'	WB				Light gray sandy clay, med.
23.5'	29.5'	WB				Light gray sandy clay, soft to med.
29.5'	34.0'	WB				Light gray sandy clay, med. to stiff
34.0'	40.0'	WB				Light gray sandy clay, soft to med.
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)
 Pumped 1 hour - 2 GPM
 Static Water Level 12.8
 Time _____ Date 9/11/81 (Completion)

CONSTRUCTION OF WELL



MW 5-2

TEST BORING LOG

Project Lake City AAP

Boring No. MW 5-2 Sheet 1 of 1

Surface Elevation 753.6 Offset

Date Started 7/28/81 Completed 7/28/81

City & State Independence, Missouri

Driller T. Butler Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	1.3'	WB				Topsoil
1.3'	5.0'	WB				Brown & gray silty clay, stiff
5.0'	6.4'	WB				Dark brown silty clay, soft
6.4'	10.0'	WB				Brown silty clay, stiff
10.0'	20.0'	WB				Gray brown silty clay, stiff
.0'	24.5'	WB				Gray brown silty clay, soft
24.5'	27.5'	WB				Gray brown silty clay, stiff
27.5'	29.5'	WB				Tan & green weathered shale, med.
29.5'	31.0'	WB				Same
31.0'	34.0'	WB				Same
34.0'	35.0'	WB				Weathered shale & gray shale, hard
35.0'	40.0'	WB				Gray shale, hard
40.0'	Total depth					

RKS: (Casing, Water Loss, Etc.)

Pumped 1-1/2 hour - 1/2 GPM

Static
Water Level

13.6

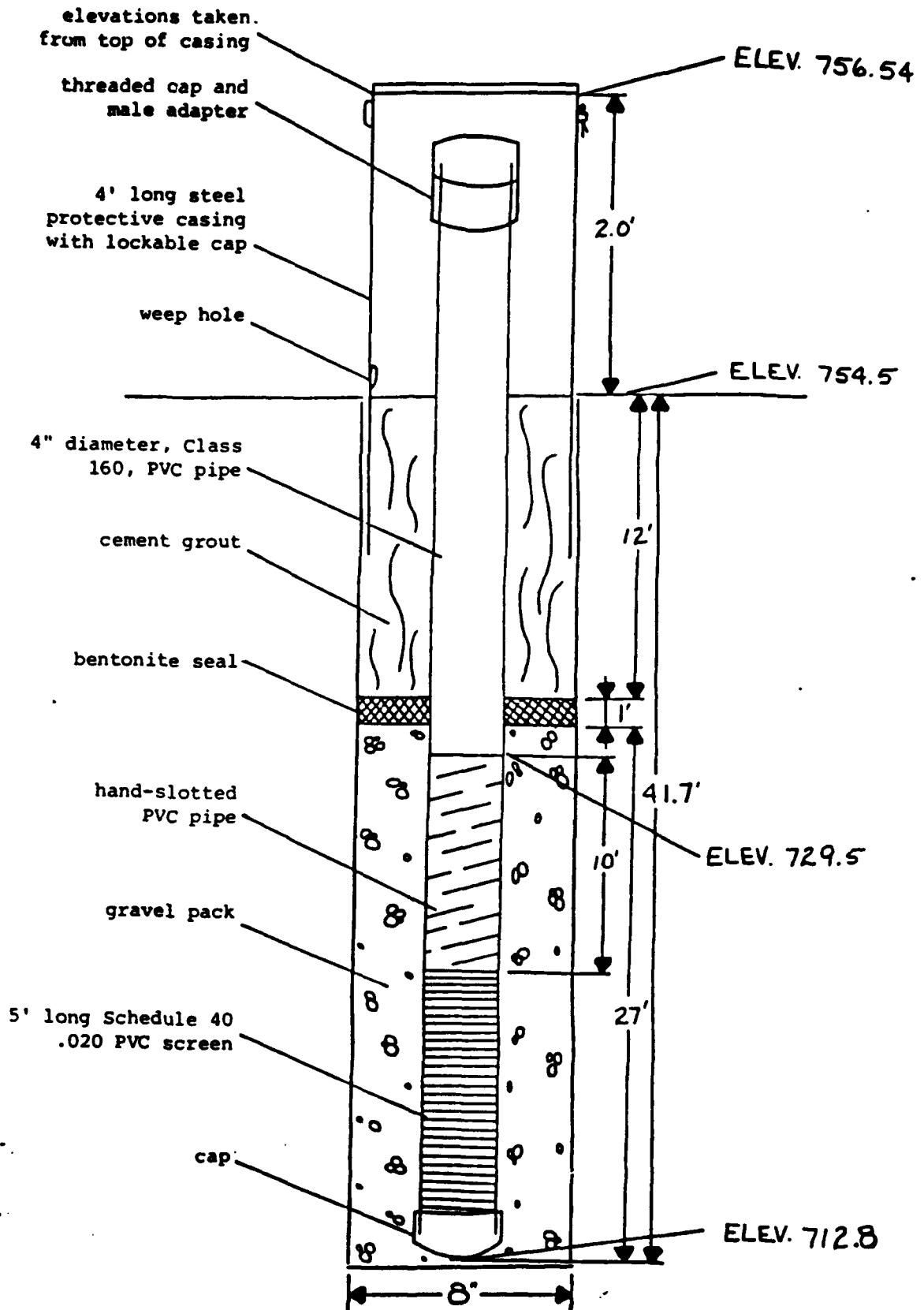
Time

Date

9/11/81

(Completion)

CONSTRUCTION OF WELL



MW 5-3

TEST BORING LOG

Project Lake City AAP

Boring No. MW 5-3 Sheet 1 of 1

Surface Elevation 754.5 Offset _____

Add _____

Date Started 8/10/81 Completed 8/11/81

City & State Independence, Missouri

Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Gray brown silty clay, stiff
5.0'	10.0'	WB				Same
10.0'	15.0'	WB				Same
15.0'	16.5'	ST1	1.75			Same
16.5'	20.0'	WB				Same
20.0'	25.0'	WB				Same
25.0'	30.0'	WB				Same
30.0'	35.0'	WB				Same
35.0'	35.5'	WB				Gray brown silty clay w/trace sand, stiff
35.5'	40.0'	WB				Yellow brown sandy clay w/trace gravel, med.
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

umped 2 hours - 1/2 GPM

Static
Water Level

Time

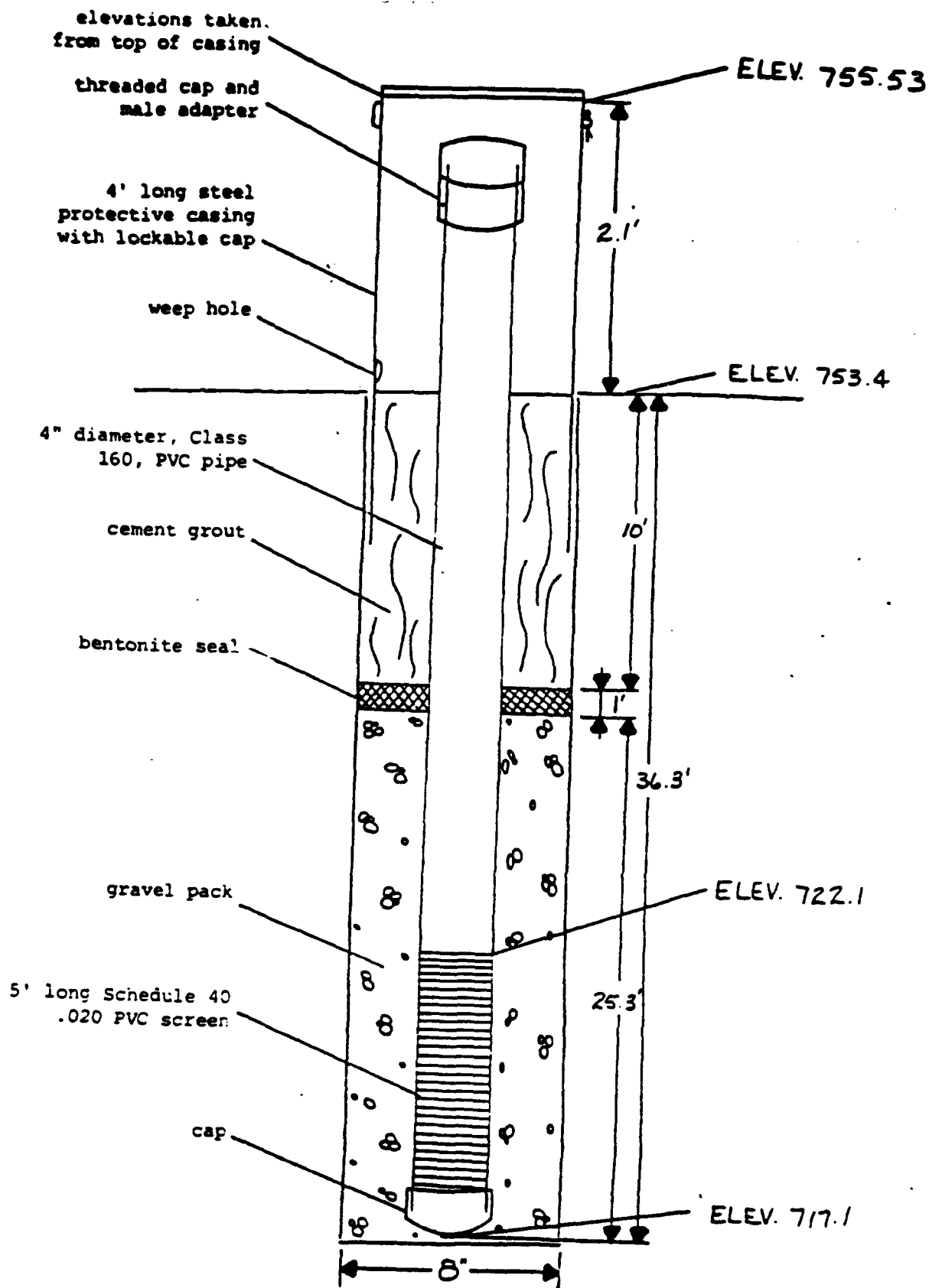
Date

13.9

9/11/81 (Completion)

Pyne-Western Company, Inc.

C-216



MW 5-4

TEST BORING LOG

Project **Lake City AAP**

Boring No. MW 5-4 Sheet 1 of 1

Surface Elevation 753.4 Offset

Ad. _____

Date Started 7/28/81 Completed 7/28/81

City & State Independence, Missouri

Driller J. Von Holt Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date

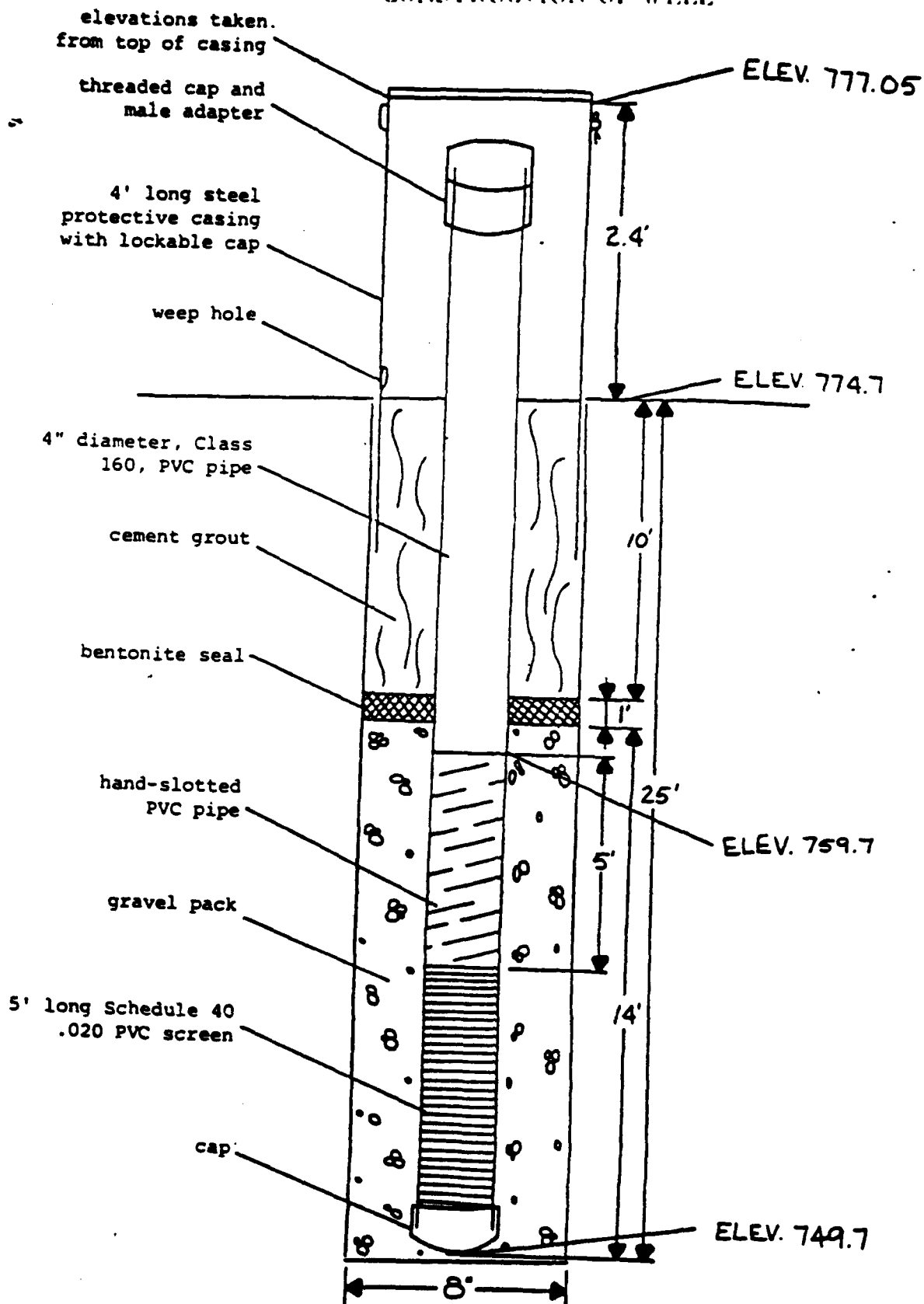
7.4

9/11/81 (Completion)

Syco-Western Company, Inc.

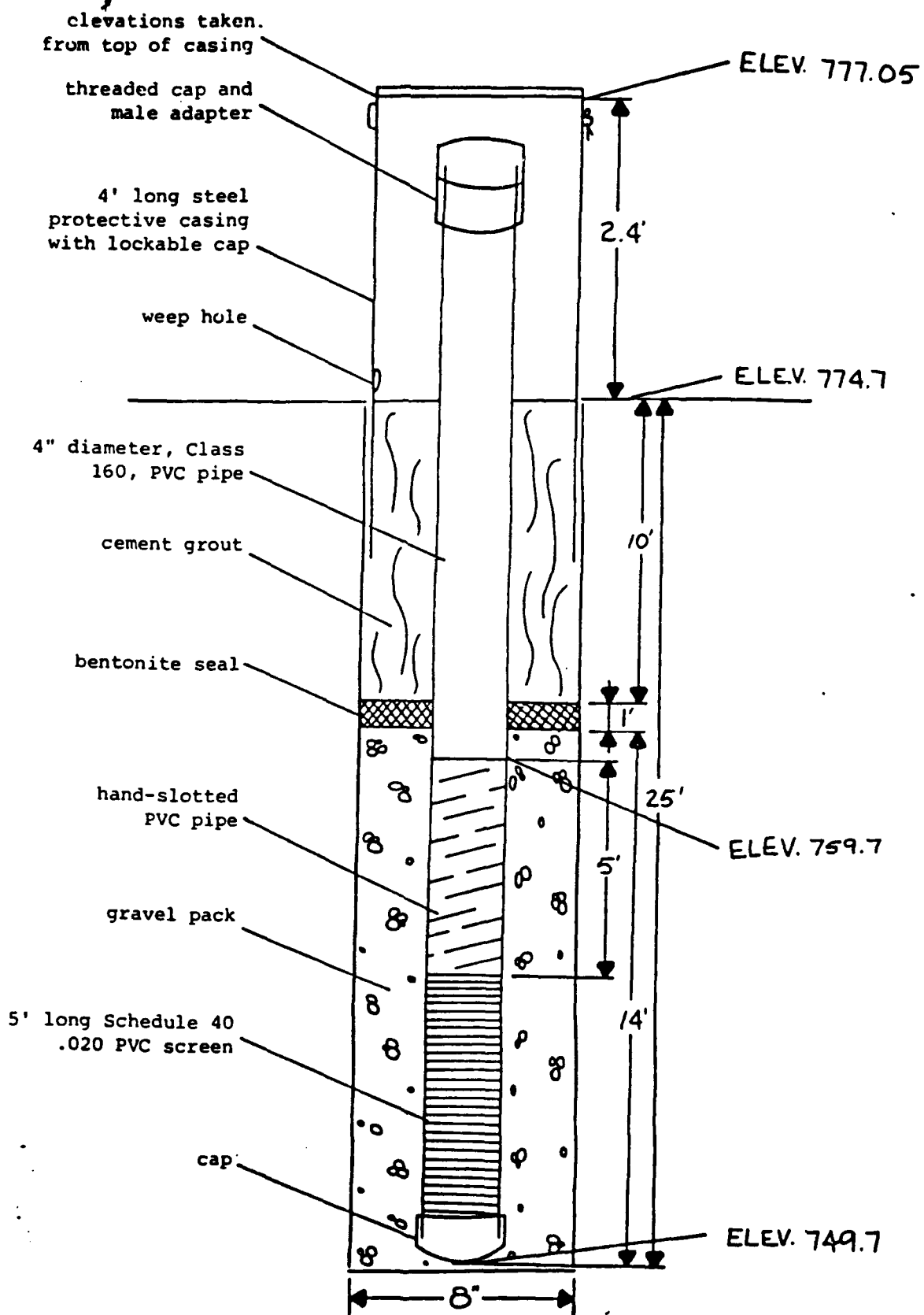
C-218

CONSTRUCTION OF WELL



MW 6-1

CONSTRUCTION OF WELL



MW 6-1

TEST BORING LOG

act Lake City AAP

Boring No. MW 6-1 Sheet 1 of 1

Surface Elevation 774.7 Offset

Date Started 8/5/81 Completed 8/5/81

& State Independence, Missouri

Driller D. Vogt Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

A: S: (Casing, Water Loss, Etc.)

STATIC Water Level

Time

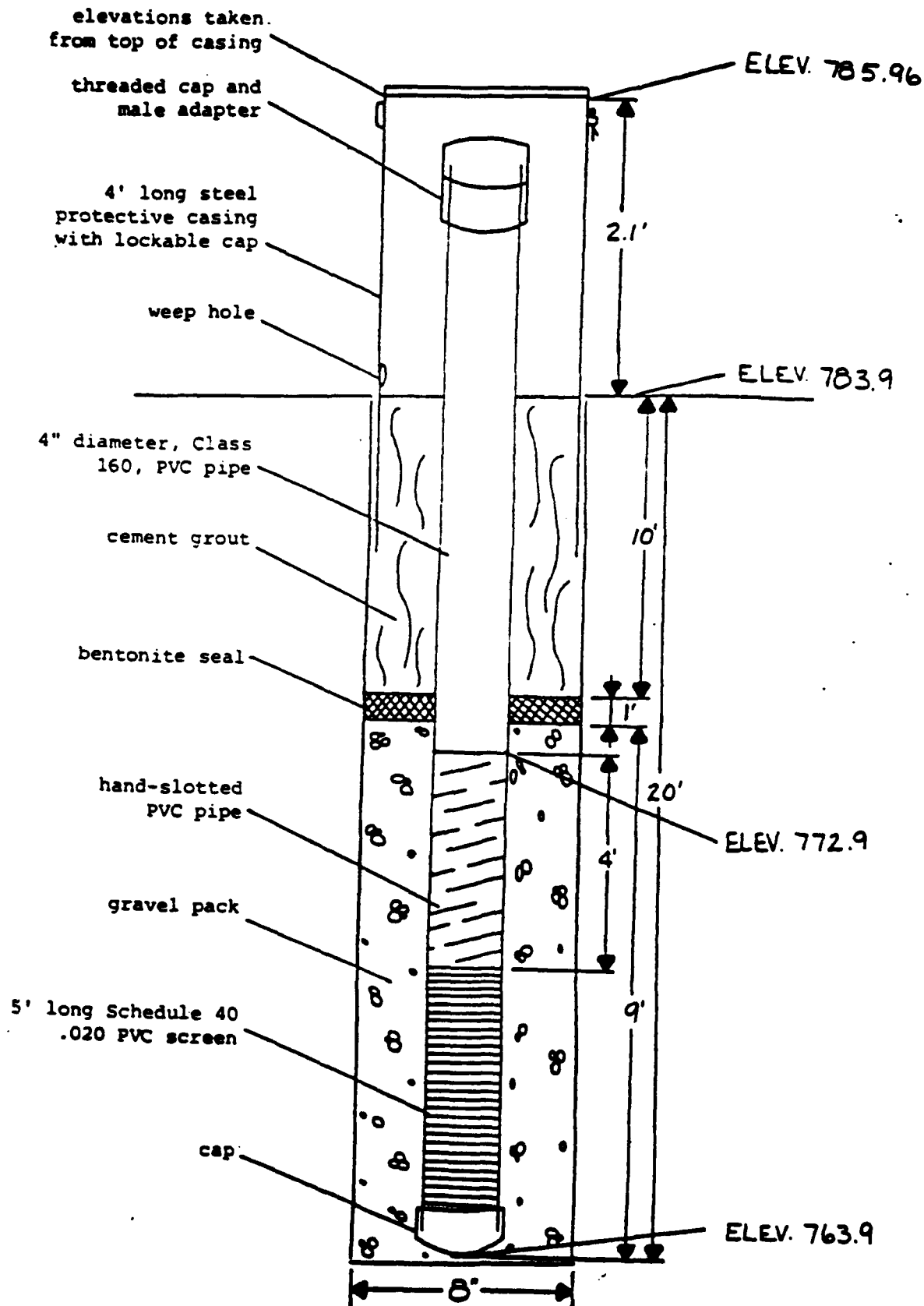
Date

Pumped 1-1/2 hour - 1 GPM

7.5

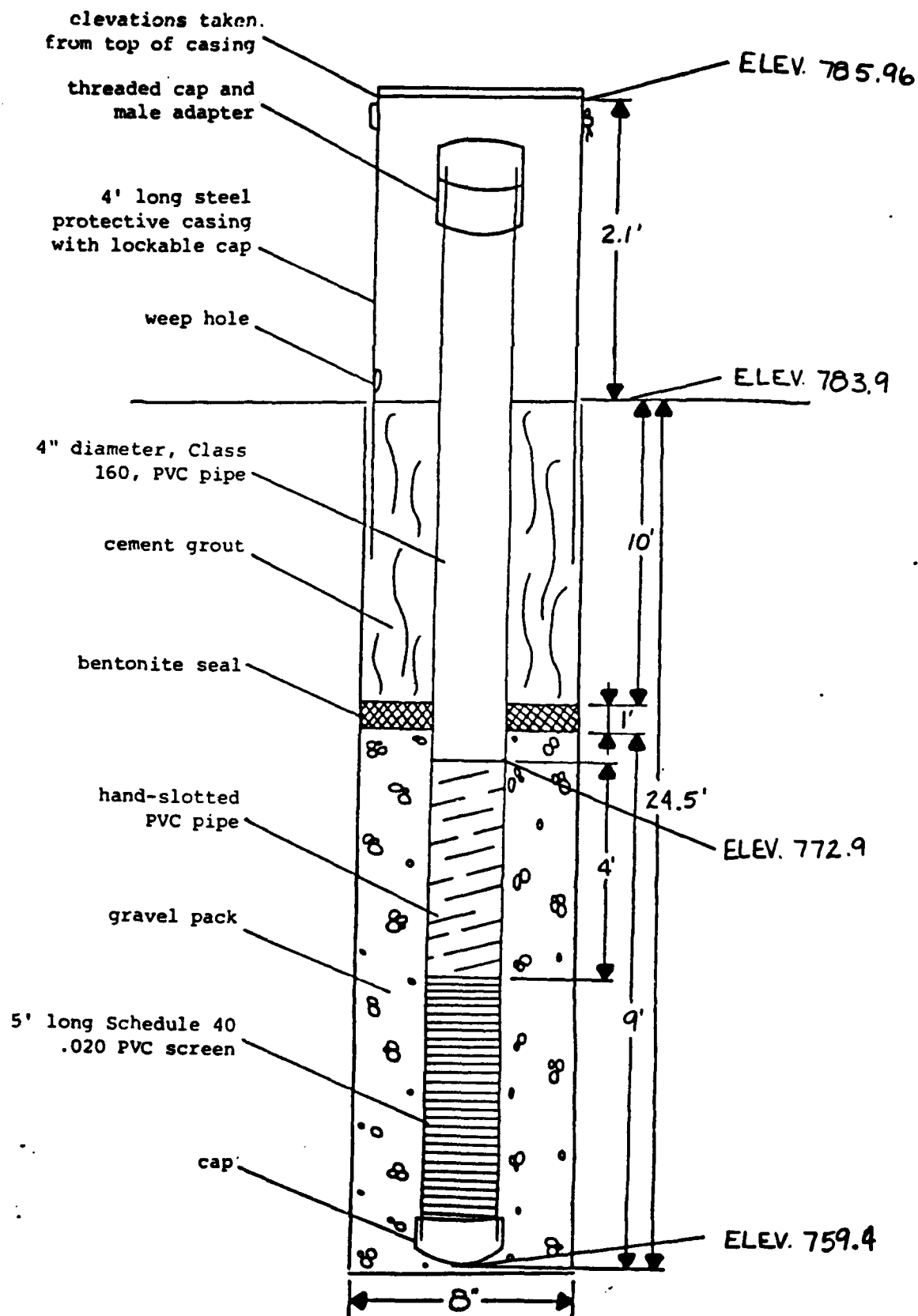
9/10/81 (Completion)

CONSTRUCTION OF WELL



MW 6-2

CONSTRUCTION OF WELL



MW 6-2

C-223

REDEVELOPMENT 2/85

Project LAKE CITY MAP

Boring No. MW 6-2 Sheet 1 of

Surface Elevation 783.9 Offset

Date Started 8/6/81 Completed 8/6/81

Driller D. Vgt Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date

Pumped 1-1/2 hour - 1-1/2 GPM

4.2

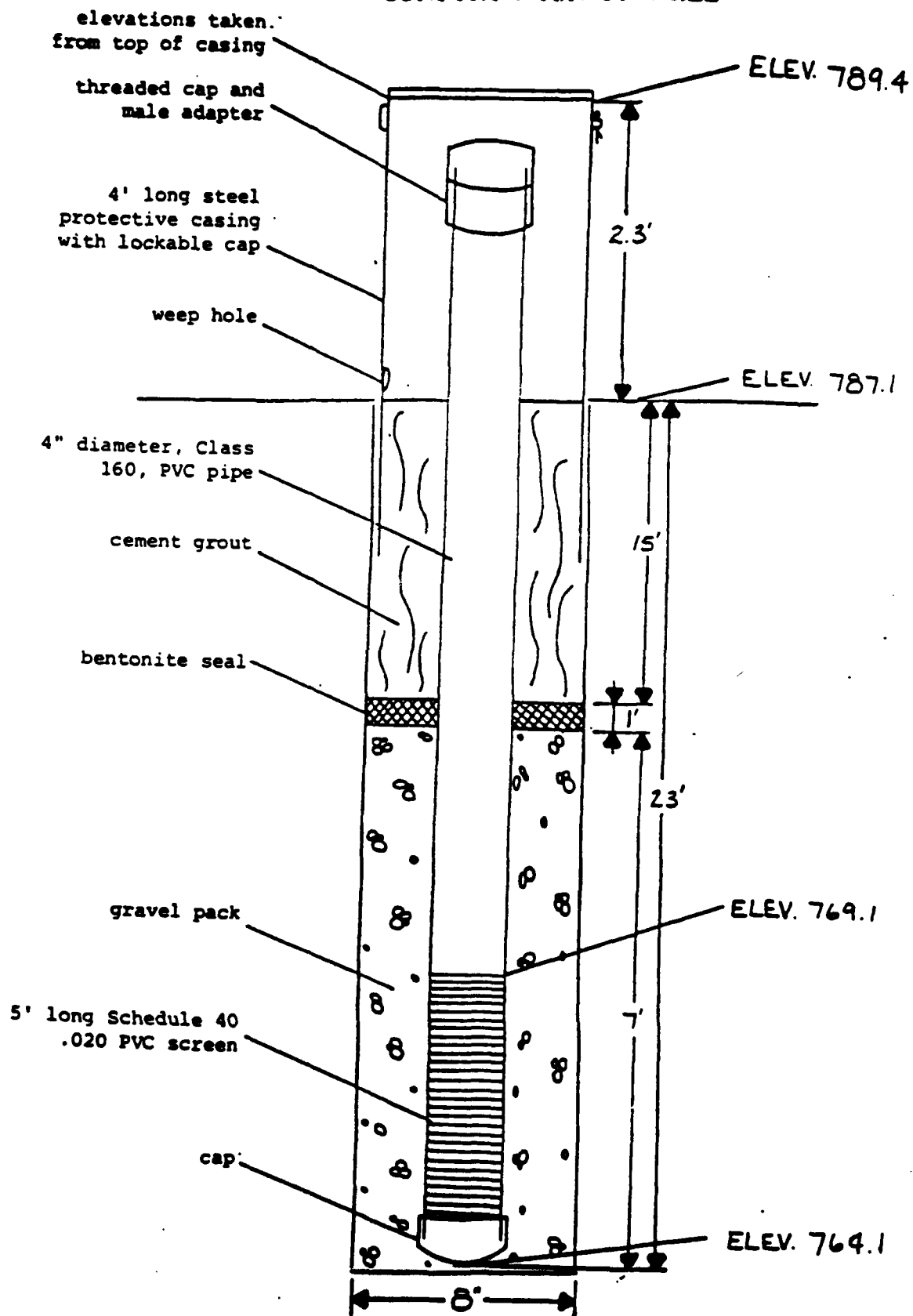
9/10/81 (Completo)

(Completion)

ayne-Western Company, Inc.

C-224

CONSTRUCTION OF WELL



MW 6-3

TEST BORING LOG

Project Lake City AAP Boring No. MW 6-3 Sheet 1 of 1
 Address _____ Surface Elevation 787.1 Offset _____
 City & State Independence, Missouri Date Started 8/6/81 Completed 8/6/81
 Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO METER	NO OF BLOWS		
0.0'	0.5'	WB				Topsoil
0.5'	4.0'	WB				Dark brown silty clay, med. to stiff
4.0'	9.0'	WB				Light brown silty clay, med. to stiff
9.0'	10.5'	ST1	3.5			Light brown silty clay, very stiff
10.5'	13.5'	WB				Tan silty clay w/trace weathered shale stiff
13.5'	19.0'	WB				Light tan shaly clay, stiff
19.0'	20.0'	ST2	4.5			Light tan & gray shaly clay, very stiff
20.0'	22.5'	WB				Light gray shale, med. to hard
22.5'	27.5'	WB				Same
27.5'	28.0'	WB				Dark gray sandy shale, med. to hard
28.0'	30.0'	WB				Light gray shale, med. to hard
30.0'	31.0'	WB				Same
31.0'	33.5'	WB				Dark gray sandy shale, med. to hard
33.5'	40.0'	WB				Light gray shale, med. to hard
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

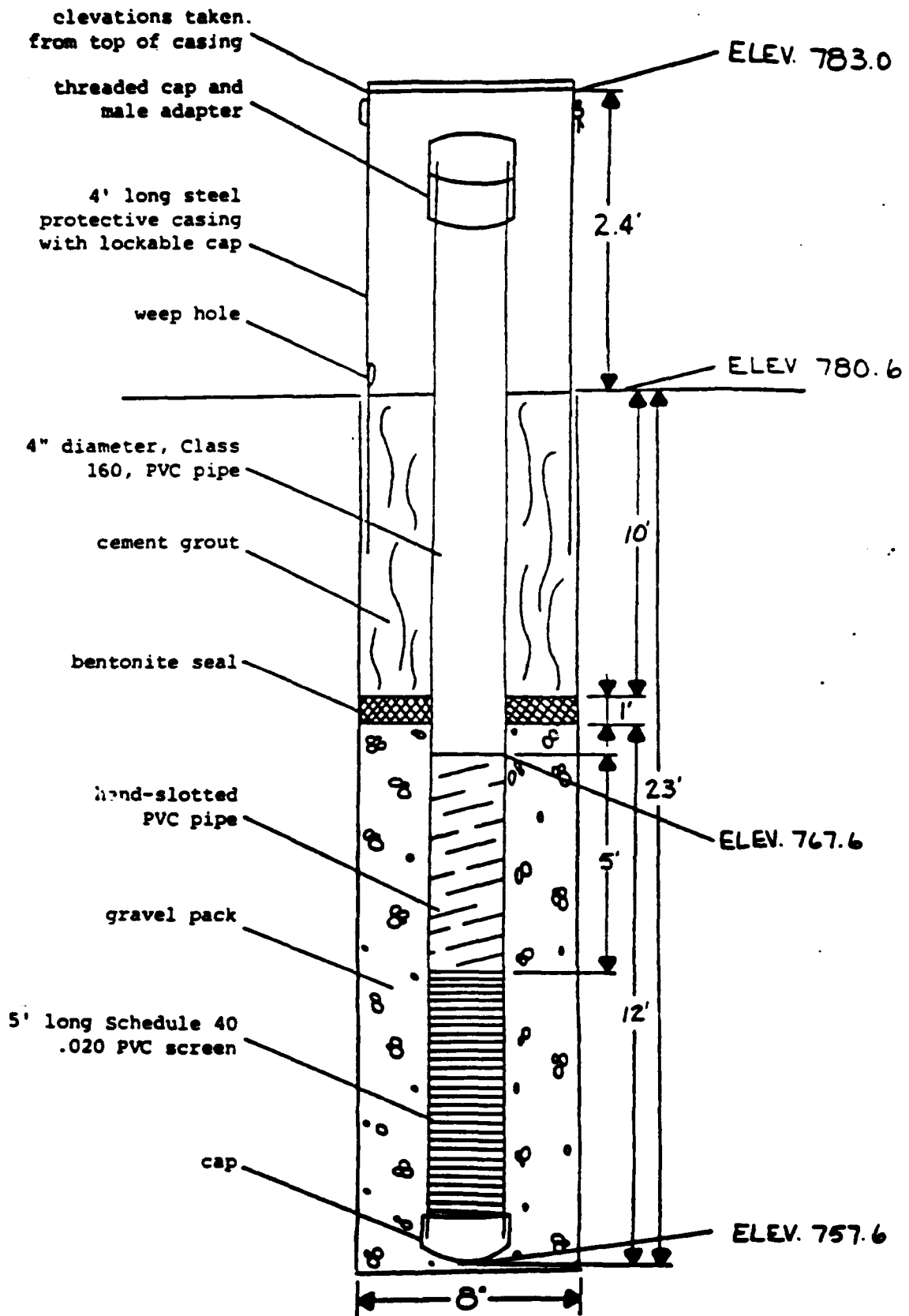
Date

Completed 1 hour - 1-1/2 GPM

1.5

9/10/81 (Completion)

CONSTRUCTION OF WELL



MW 6-4

TEST BORING LOG

Project Lake City AAP
 City & State Independence, Missouri

Boring No. MW 6-4 Sheet 1 of 1
 Surface Elevation 780.6 Offset _____
 Date Started 8/13/81 Completed 8/13/81
 Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO METER	NO OF BLOWS		
0.0'	0.9'	WB				Topsoil
0.9'	3.5'	WB				Brown silty clay, med.
3.5'	7.0'	WB				Dark gray silty clay, med.
7.0'	9.5'	WB				Light brown silty clay, med. to stiff
9.5'	11.0'	ST1	4.5			Light brown silty clay, very stiff
11.0'	12.5'	WB				Same
12.5'	15.5'	WB				Light tan shaly clay, stiff
15.5'	16.0'	WB				Weathered shale, hard
16.0'	21.5'	WB				Light tan shaly clay, med. to stiff
21.5'	23.0'	WB				Light gray shale, med. to hard
23.0'	25.0'	WB				Dark gray shale, med. to hard
25.0'	40.0'	WB				Light gray shale, med. to stiff
0.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

u ad 1-1/2 hour - 1-1/2 GPM

Static
Water Level

3.7

Time

Date

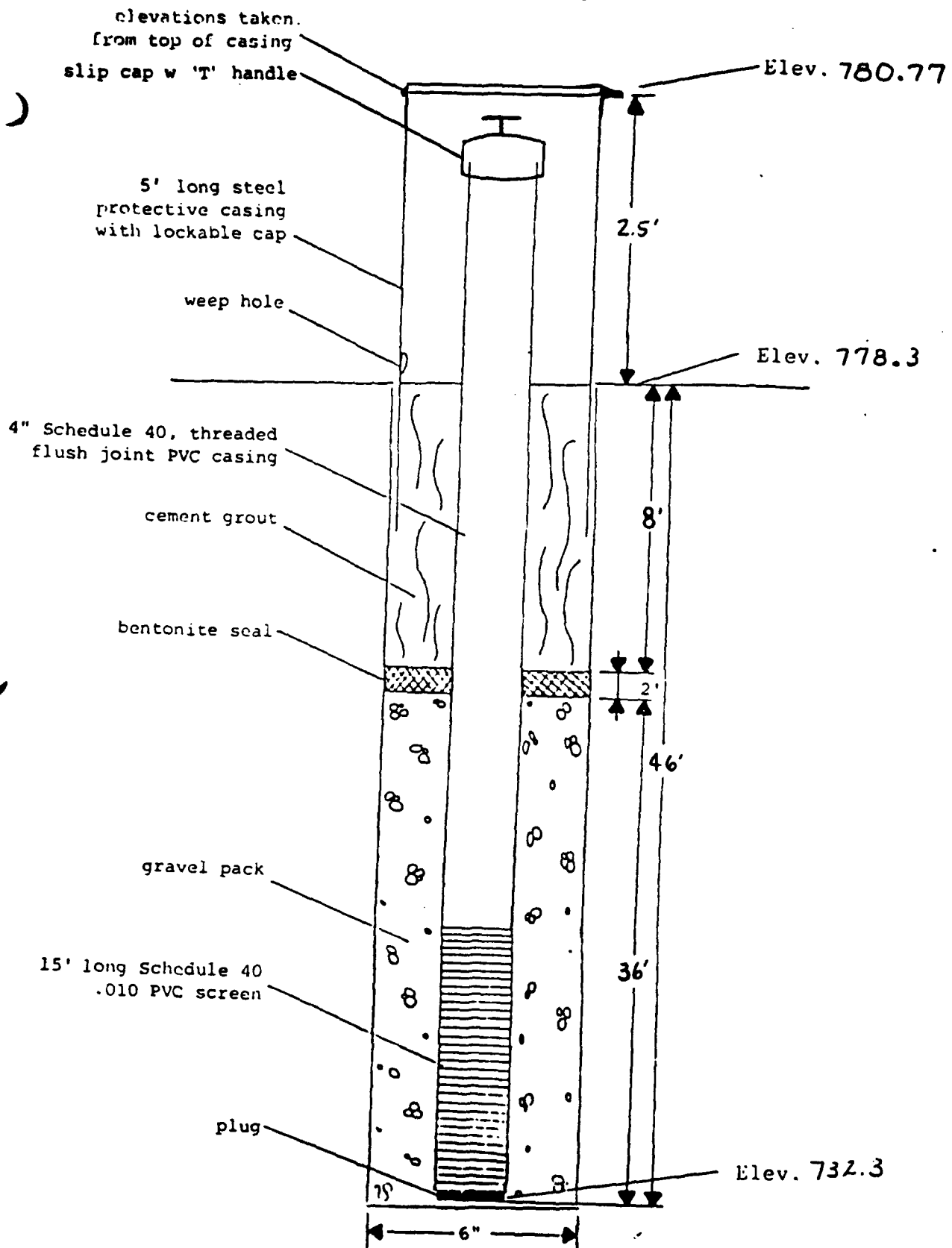
9/10/81

(Completion)

ne-Western Company, Inc.

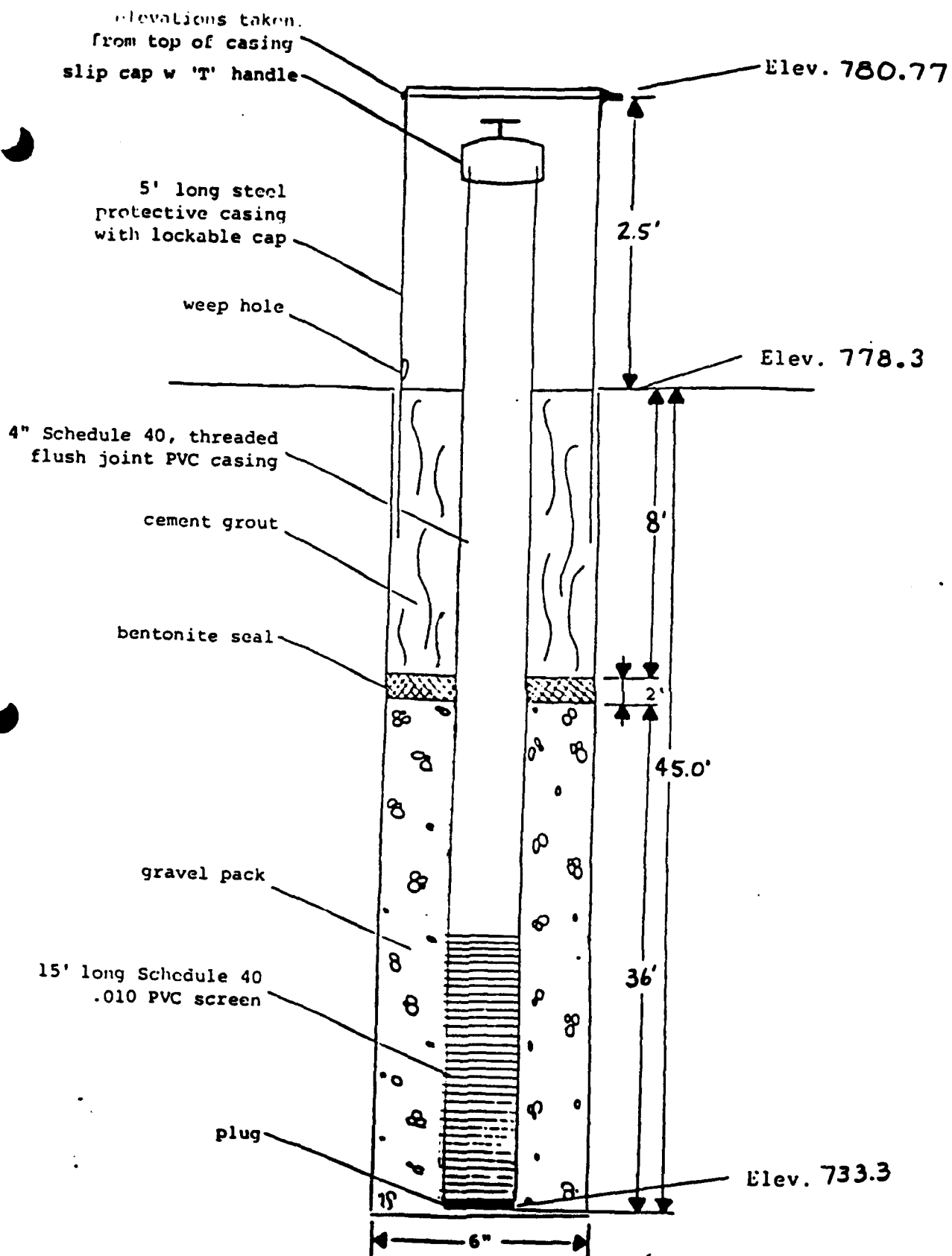
C-228

WELL CONSTRUCTION



MW 6-5

C-229



12/17 6-5

C-230 Redevelopment 2/85

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 6-5

Sheet 1 of 1

Address _____

Surface Elevation 778.3 Offset _____

Date Started 1/5/83 Completed 1/5/83

City & State Independence, Missouri

Driller R. Kelly Rig CME-55

Abbreviations:

A.O. - Auger Only

R.B. - Rock Bit

C.W. - Core Water

H.A. - Hollow Auger

S.S. - Split Spoon

C.A. - Core Air

W.B. - Wash Bore

S.T. - Shelby Tube

F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	0.6'	HA				Topsoil
0.6'	5.5'	HA				Dark brown silty clay, moist, very stiff
5.5'	8.7'	HA				Brown silty clay, moist, very stiff
8.7'	9.2'	HA				Yellow brown shaly clay, moist, very stiff
9.2'	13.0'	HA				Yellow brown clayey shale, moist, very stiff
13.0'	18.0'	HA				Olive brown shale, dry, med. to hard
18.0'	23.0'	HA				Yellow weathered shaly sandstone, dry, med. to hard
23.0'	25.5'	HA				Yellow brown weathered shale, dry, med. to hard
25.5'	31.0'	HA				Gray shale, dry, med. to hard
31.0'	40.0'	HA				Gray clayey shale, moist, soft to med.
40.0'	46.0'	HA				Gray clayey shale, very moist, soft
46.0'	Total depth					

ARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

28.2

4:00pm

1/5/83

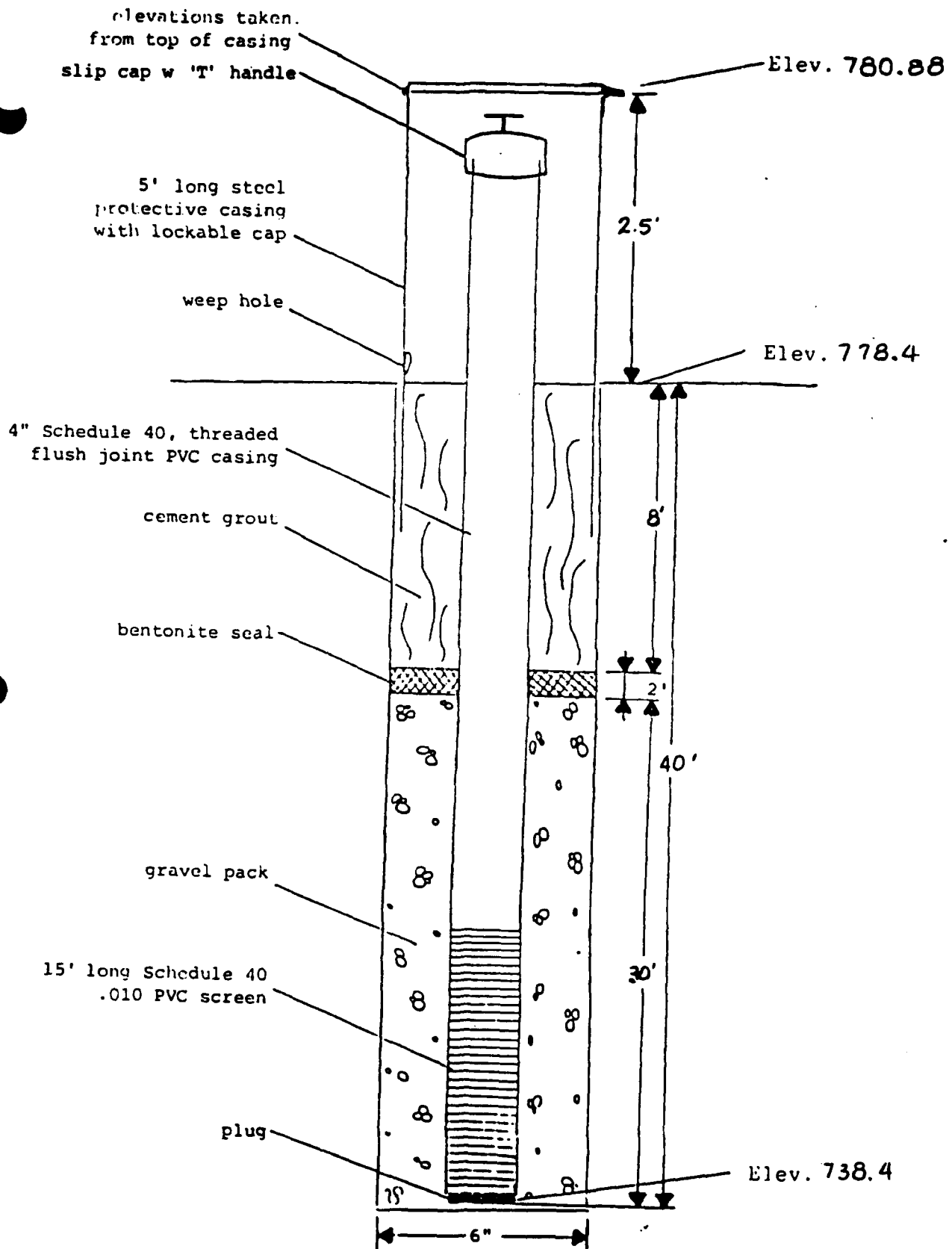
(Completion)

18.2

3:30pm

1/6/83

WELL CONSTRUCTION



MW 6-6

C-232

elevations taken
from top of casing
slip cap w 'T' handle

5' long steel
protective casing
with lockable cap

weep hole

4" Schedule 40, threaded
flush joint PVC casing

cement grout

bentonite seal

gravel pack

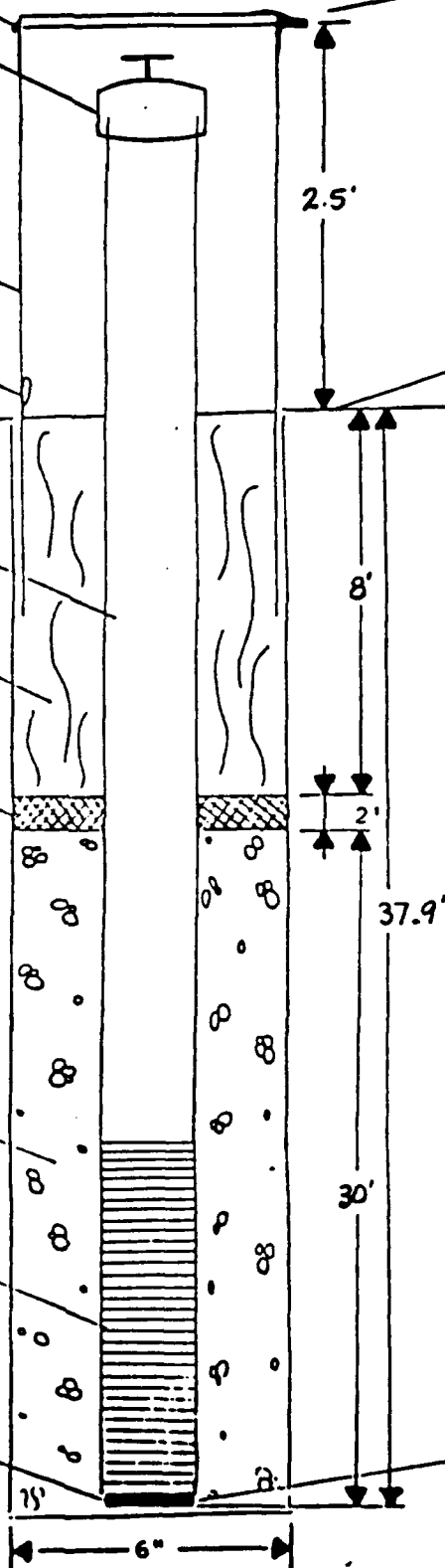
15' long Schedule 40
.010 PVC screen

plug

Elev. 780.88

Elev. 778.4

Elev. 740.5



HW 6-6

C-233 REDEVELOPMENT 2/85

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 6-6

Sheet 1 of 1

Address _____

Surface Elevation 778.4 Offset _____

Date Started 1/7/83 Completed 1/7/83

City & State Independence, Missouri

Driller R. Kelly Rig CME-55

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	0.6'	HA				Topsoil
0.6'	6.3'	HA				Dark brown silty clay, moist, stiff
6.3'	13.5'	HA				Light brown silty clay, moist, very stiff
13.5'	22.5'	HA				Brown gray shaly sandstone, slightly moist, med. to hard
22.5'	29.0'	HA				Gray shale, slightly moist, med. to hard
29.0'	30.0'	HA				Gray shale, moist, med. to soft
30.0'	35.0'	HA				Gray shale, very moist, soft to very soft
35.0'	36.5'	ST1			0.0'	Same
36.5'	40.0'	HA				Gray shale, moist, soft
40.0'	41.5'	ST1	1.75		1.3'	Gray shale, moist, soft to med.
41.5'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

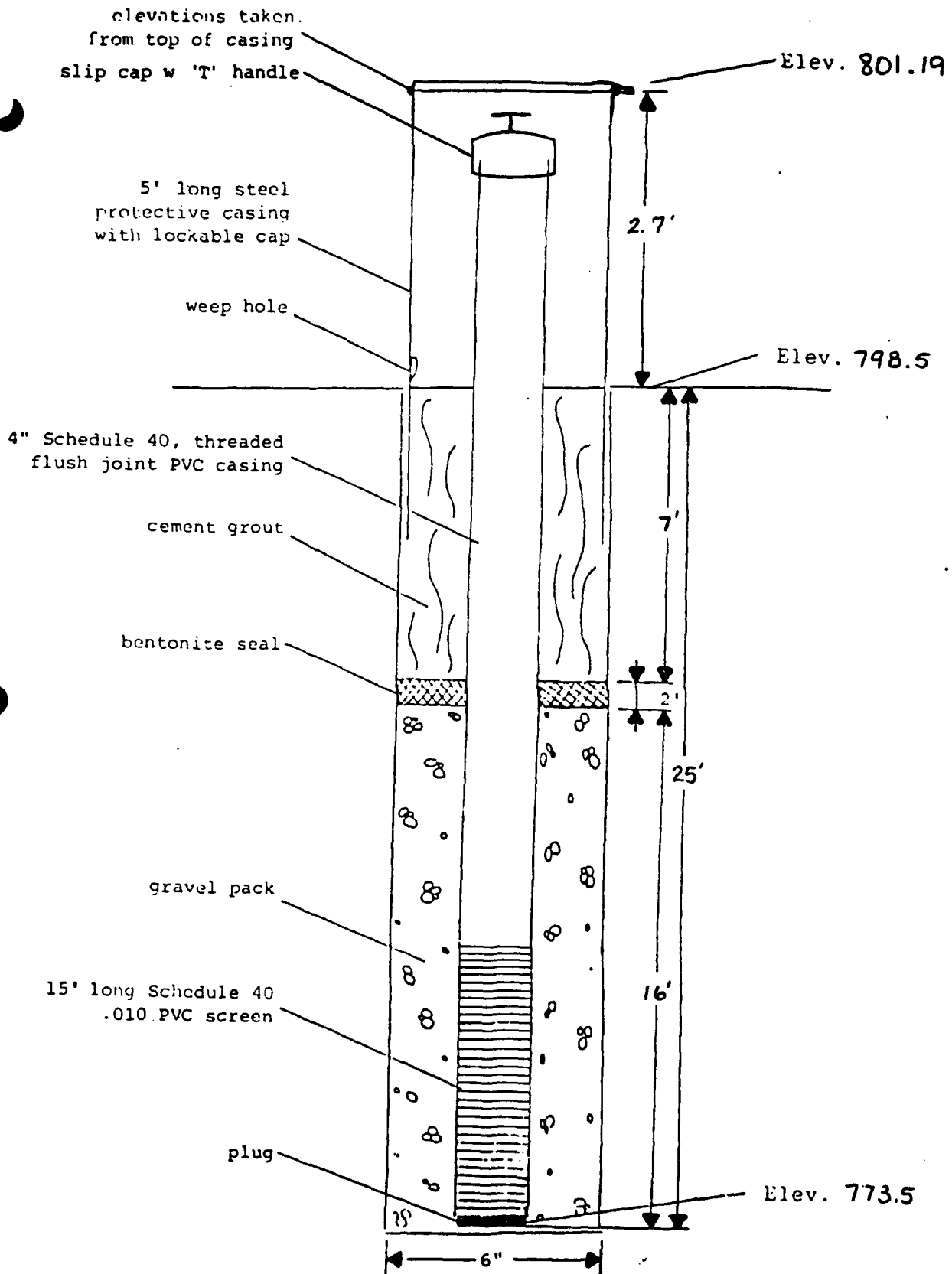
20.0

4:00pm

1/7/83

(Completion)

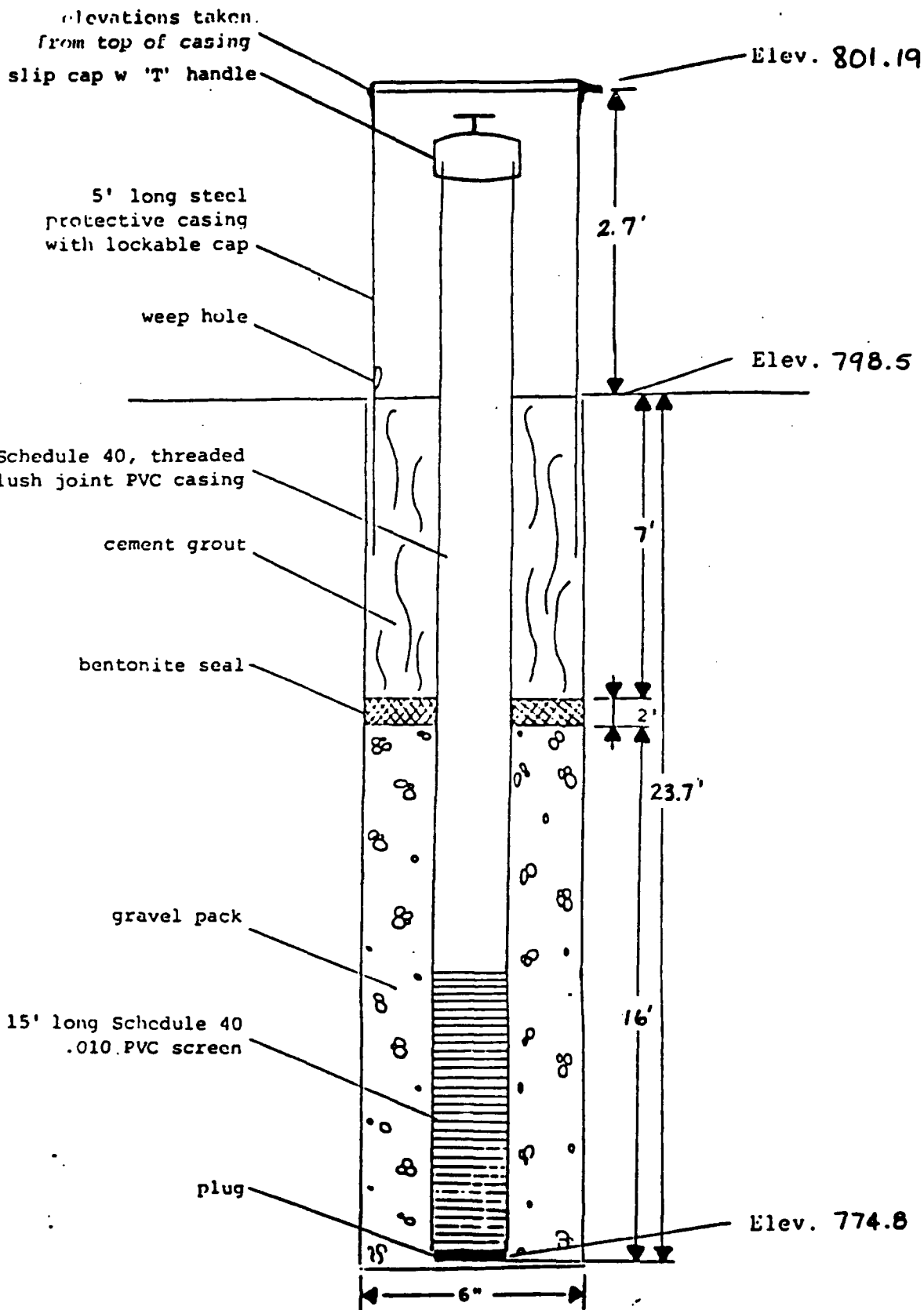
WELL CONSTRUCTION



NW 6-7

C-235

WELL CONSTRUCTION



MW 6-7

C-236 REDEVELOPMENT 2/85

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 6-7 Sheet 1 of 1

Surface Elevation 798.5 Offset

Address _____

Date Started 1/6/83 Completed 1/6/83

City & State **Independence, Missouri**

Driller R. Kelly Rig CME-55

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**MARKS: (Casing, Water Loss, Etc.)**

Water Level

Time

Date

5.0

12:00pm

1/6/83

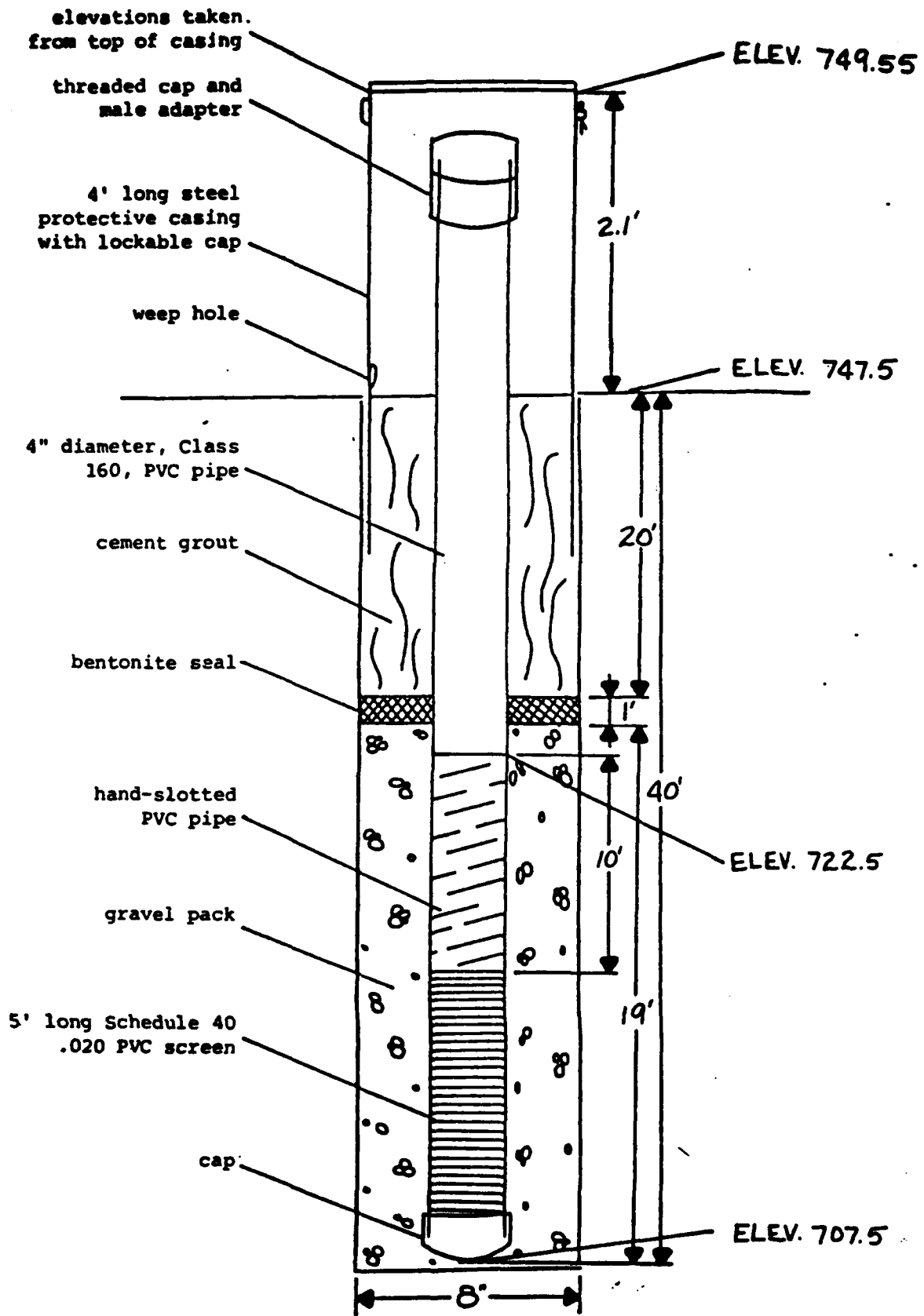
(Completion)

3.0

3 : 30pm

1/6/83

CONSTRUCTION OF WELL



MW 7-1

TEST BORING LOG

Project Lake City AAP

Boring No. MW 7-1 Sheet 1 of 1

Surface Elevation 747.5 Offset

Address

Date Started 8/4/81 Completed 8/4/81

City & State Independence, Missouri

Driller T. Butler Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO. METER	NO. OF BLOWS		
0.0'	2.5'	WB				Topsoil
2.5'	4.0'	WB				Dark brown silty clay, med. to stiff
4.0'	9.0'	WB				Dark gray & brown silty clay, med. to stiff
9.0'	10.5'	ST1	2.5			Dark gray silty clay w/trace sand, med. to stiff
10.5'	15.0'	WB				Dark gray silty clay w/trace sand, soft to med.
15.0'	17.5'	WB				Dark gray silty clay, soft to med.
17.5'	19.0'	WB				Dark gray silty clay w/trace sand, soft to med.
19.0'	20.5'	WB				Dark gray silty clay, med. to stiff
20.5'	24.0'	WB				Gray silty clay, med. to stiff
24.0'	29.0'	WB				Same
29.0'	31.5'	ST2	4.5			Same
31.5'	34.5'	WB				Gray silty clay, soft to med.
34.5'	40.0'	WB				Gray fine sand
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

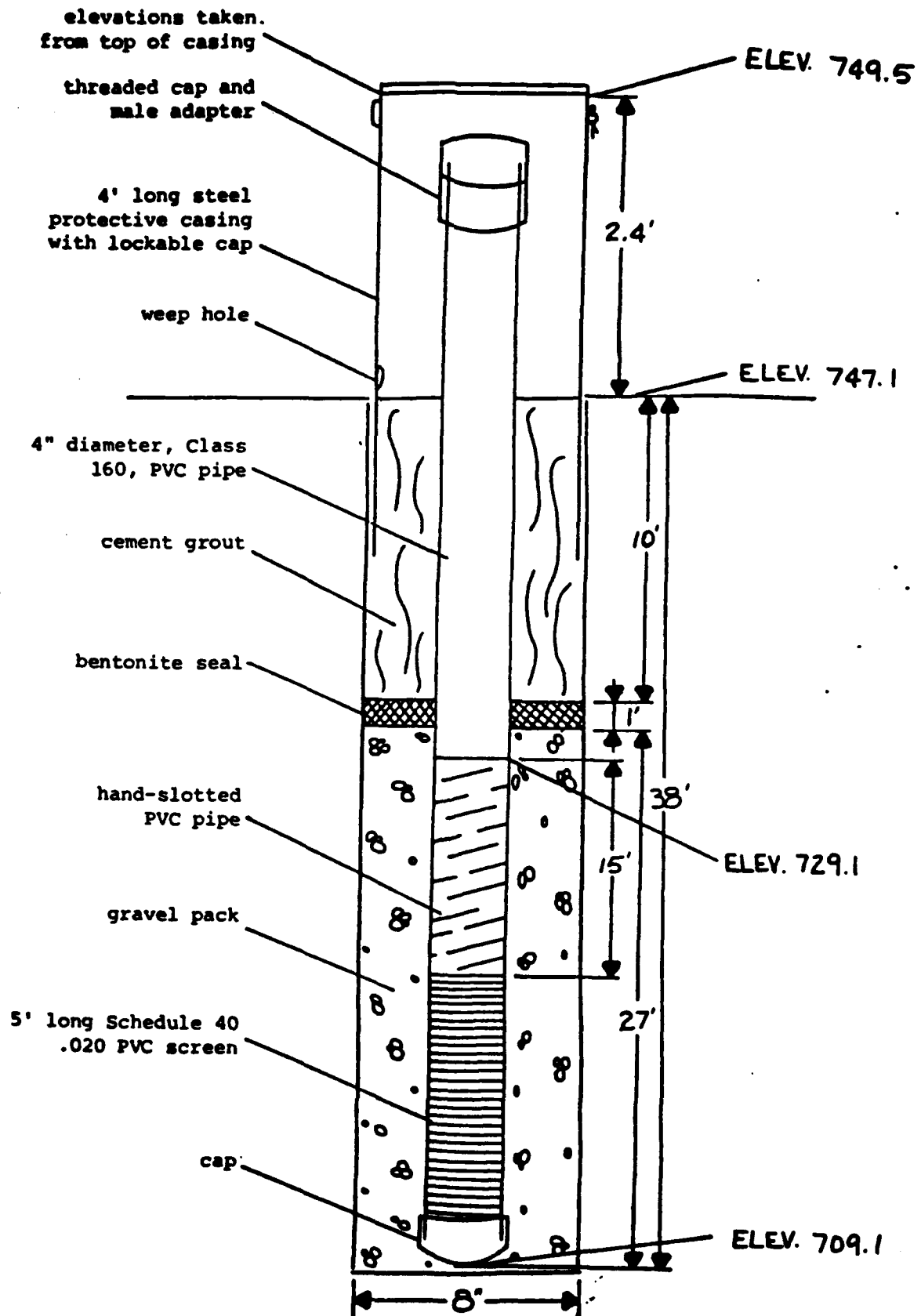
Date

Pumped 1-1/2 hour - 2 GPM

26.6

9/11/81 (Completion)

CONSTRUCTION OF WELL



MW 7-2

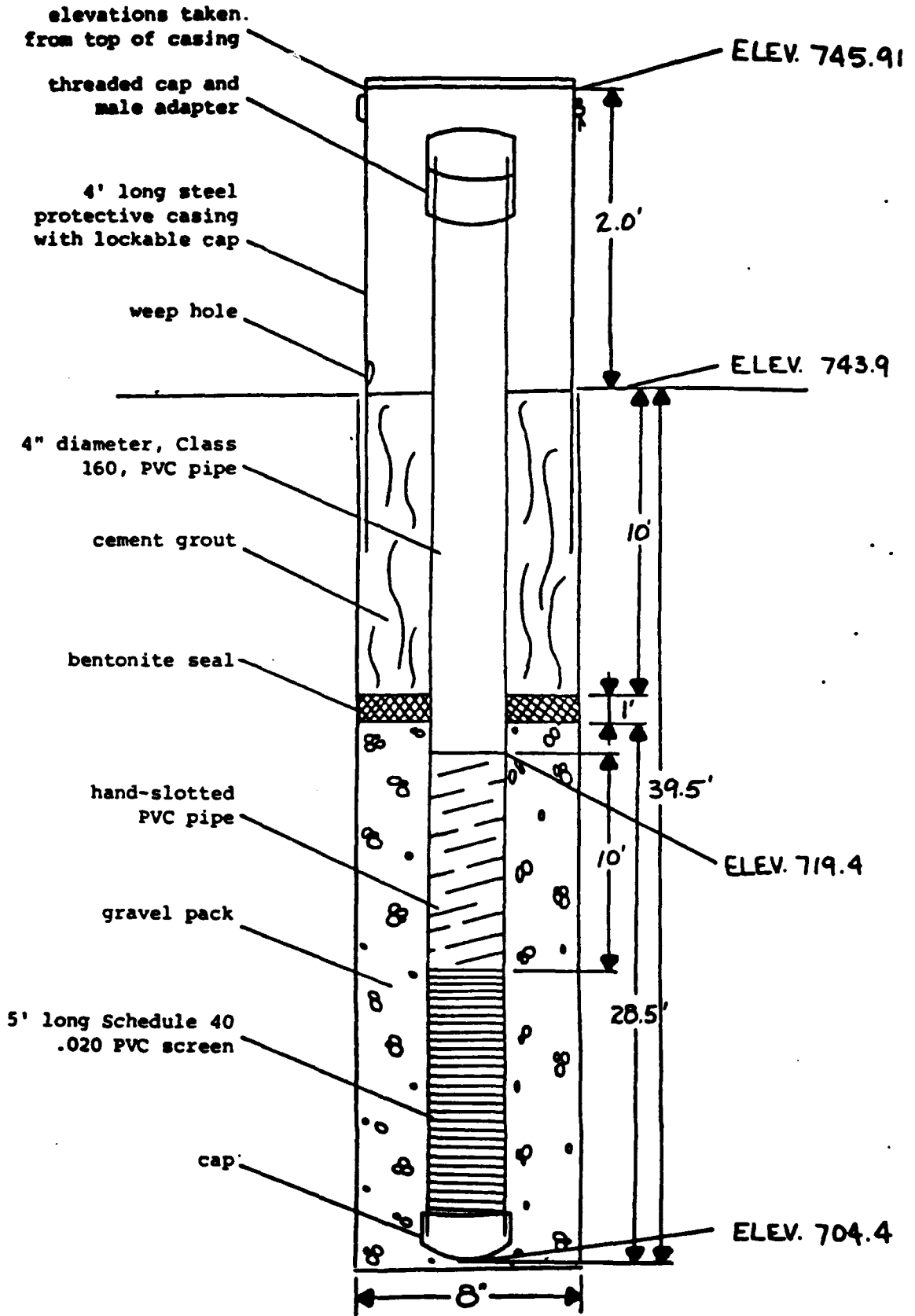
TEST BORING LOG	
Project <u>Lake City AAP</u>	Boring No. <u>MW 7-2</u> Sheet <u>1</u> of <u>1</u>
<u></u>	Surface Elevation <u>747.1</u> Offset <u></u>
Add <u></u>	Date Started <u>7/31/81</u> Completed <u>7/31/81</u>
City & State <u>Independence, Missouri</u>	Driller <u>J. Von Holt</u> Rig <u></u>

[illegible]

Layne-Western Company, Inc.

C-241

CONSTRUCTION OF WELL



MW 7-3

TEST BORING LOG

Project Lake City AAP

Boring No. MW 7-3 Sheet 1 of 1

Surface Elevation 743.9 Offset _____

Add _____

Date Started 8/21/81 Completed 8/21/81

City & State Independence, Missouri

Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Dark gray silty clay, stiff
5.0'	9.0'	WB				Same
9.0'	10.5'	ST1	1.75			Same
10.5'	12.0'	WB				Same
12.0'	15.0'	WB				Gray & brown silty clay, stiff
15.0'	19.0'	WB				Same
19.0'	20.5'	ST2	1.25			Same
20.5'	23.0'	WB				Same
23.0'	25.0'	WB				Gray silty clay, stiff
25.0'	30.0'	WB				Same
30.0'	34.0'	WB				Same
34.0'	38.0'	WB				Gray very fine sand, dense
38.0'	40.0'	WB				Gray silty clay w/trace sand, & coal, stiff
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

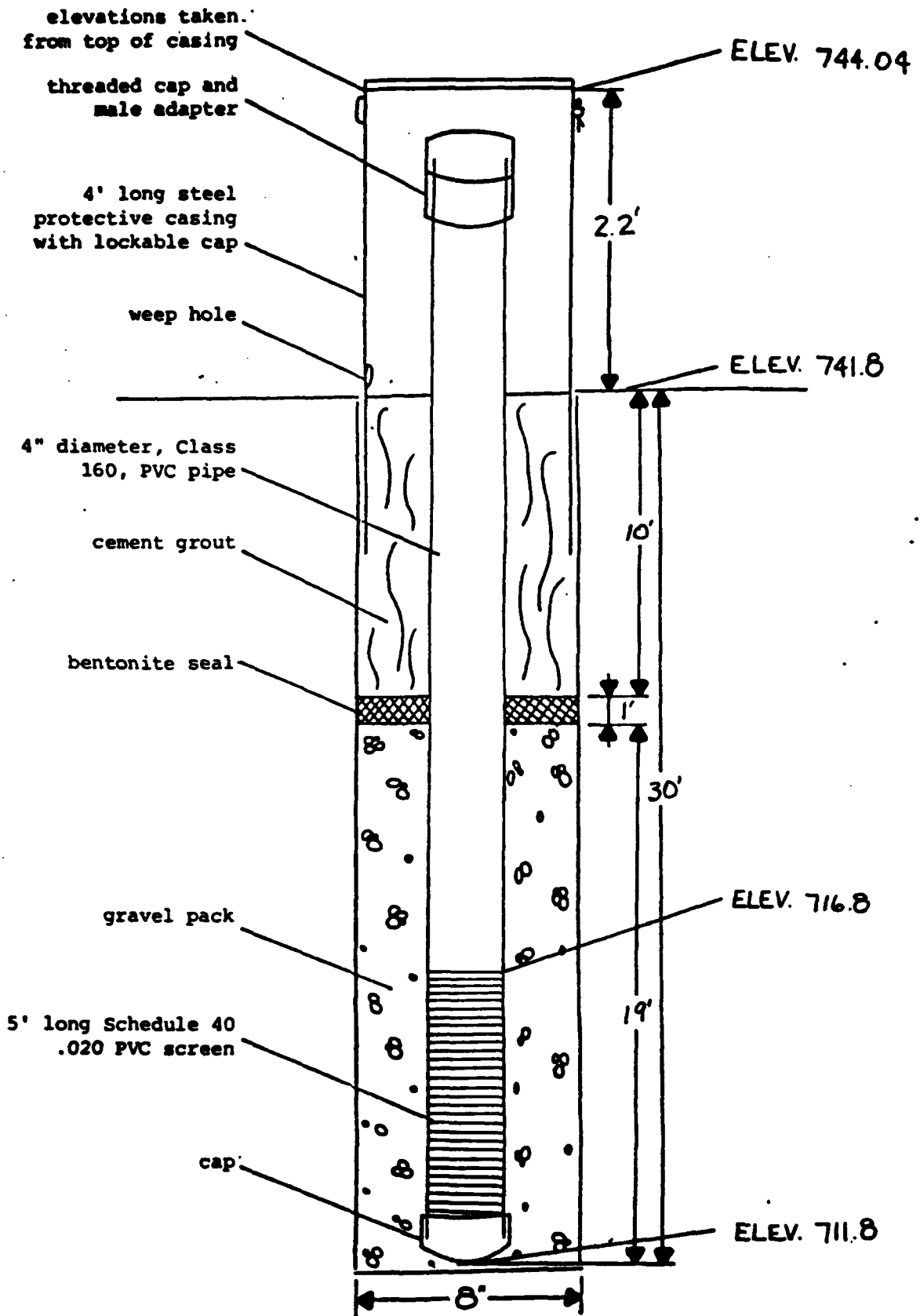
Static Water Level _____ Time _____ Date 9/11/81 (Completion)

Logged 2 hours, 1/2 GPM

5.6

9/11/81 (Completion)

CONSTRUCTION OF WELL



MW 7-4

TEST BORING LOG

Lake City AAP

Boring No. MW 7-4 Sheet 1 of 1

Surface Elevation 741.8 Offset

Date Started 8/3/81 Completed 8/3/81

Independence, Missouri

Driller T. Butler Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**MARKS: (Casing, Water Loss, Etc.)**

Static Water Level

Time

Date

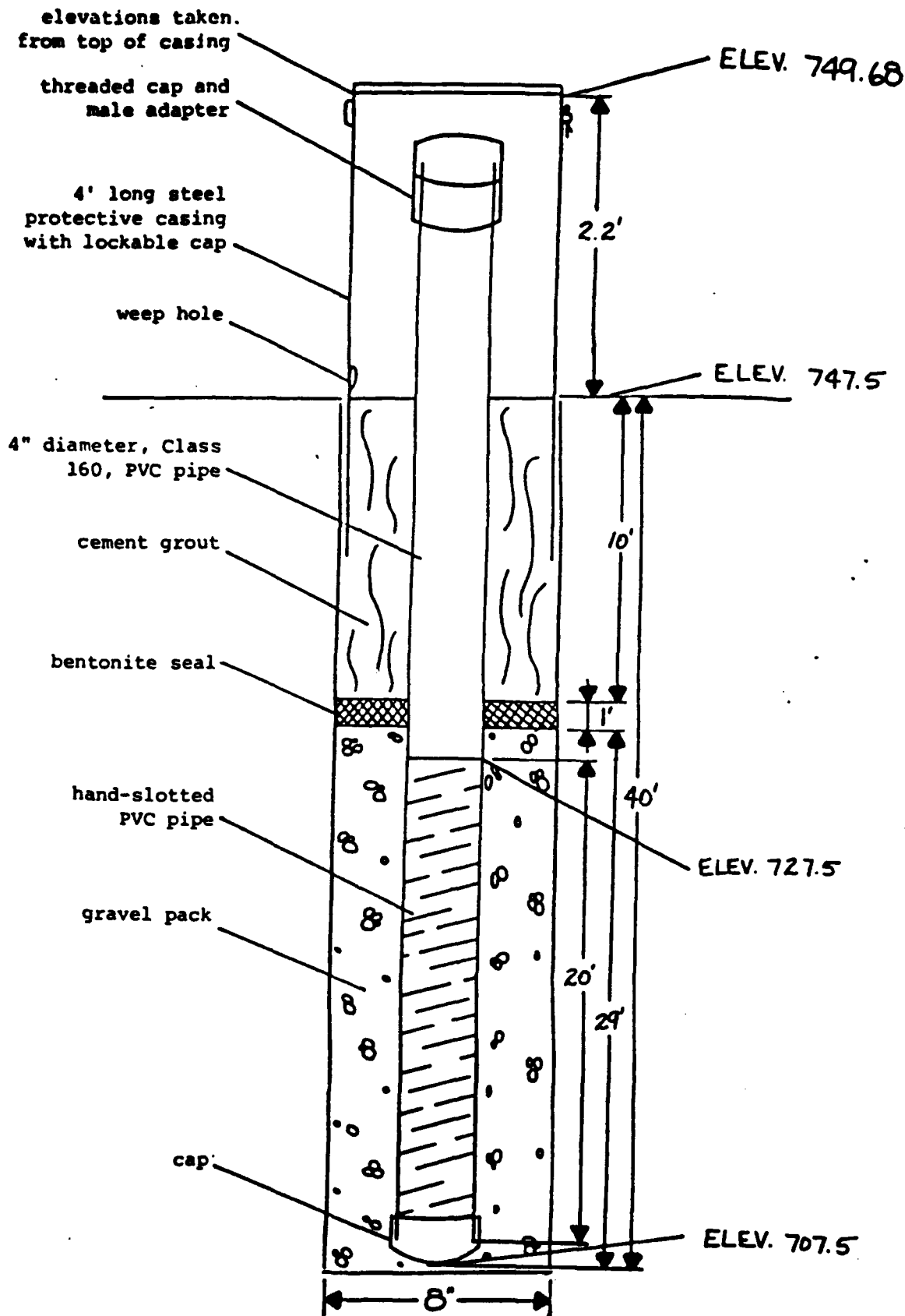
Pumped 1-1/2 hour - 6 GPM

20.7

9/11/81

(Completion)

CONSTRUCTION OF WELL



MW 7-5

TEST BORING LOG

Project Lake City AAP

Boring No. MW 7-5 Sheet 1 of 1

Surface Elevation 747.5 Offset

Add _____

Date Started 9/2/81 Completed 9/3/81

City & State Independence, Missouri

Driller T. Butler Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

• • 9KS: (Casing, Water Loss, Etc.)

Static Water Level

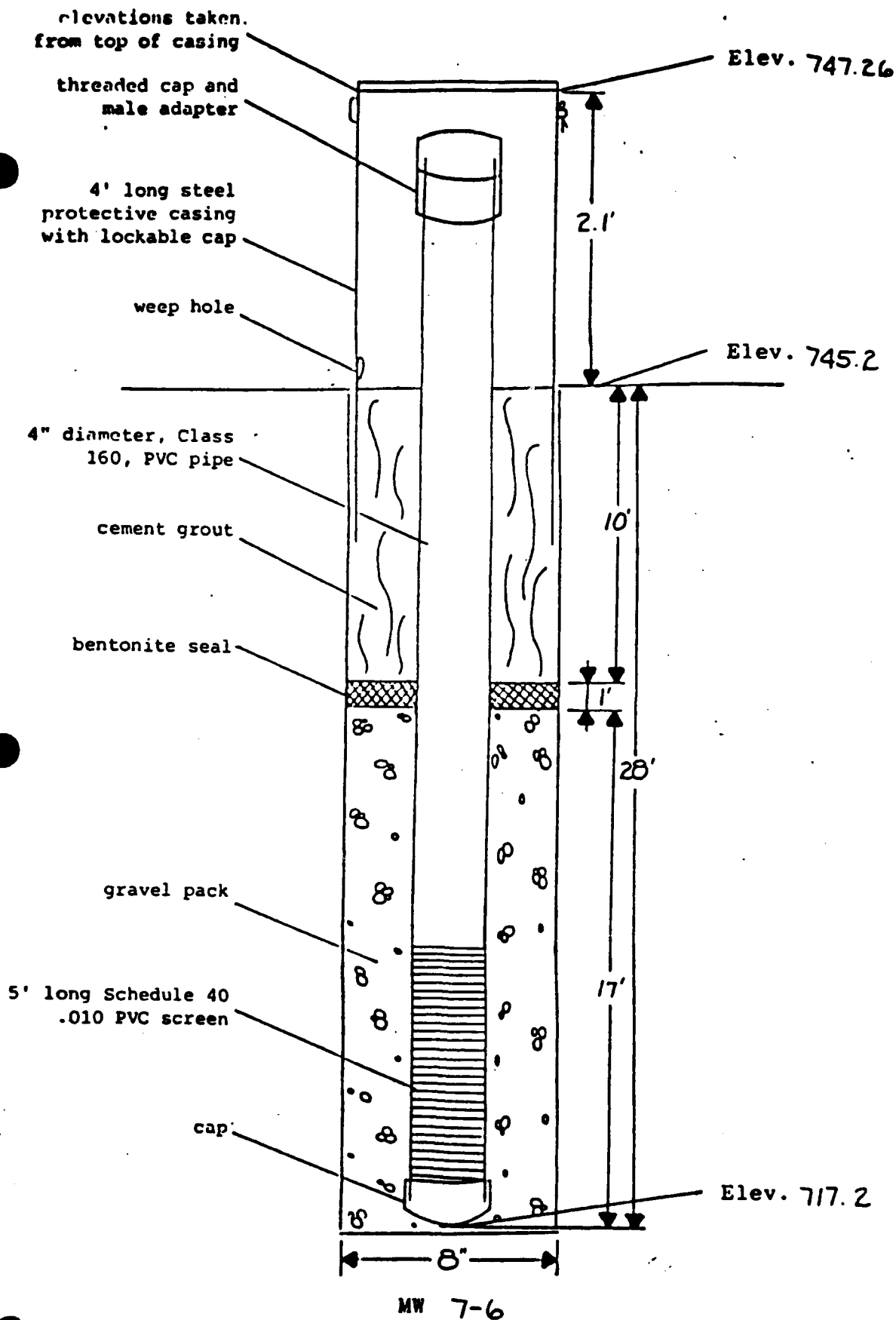
Time

Date _____

Pumped 2 hours - 10 GPM

25.1

9/11/81 (Completion)



TEST BORING LOG

Boring No. MW 7-6 Sheet 1 of 1

Surface Elevation _____ Offset _____

Date Started 1/20/82 Completed 1/20/82

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

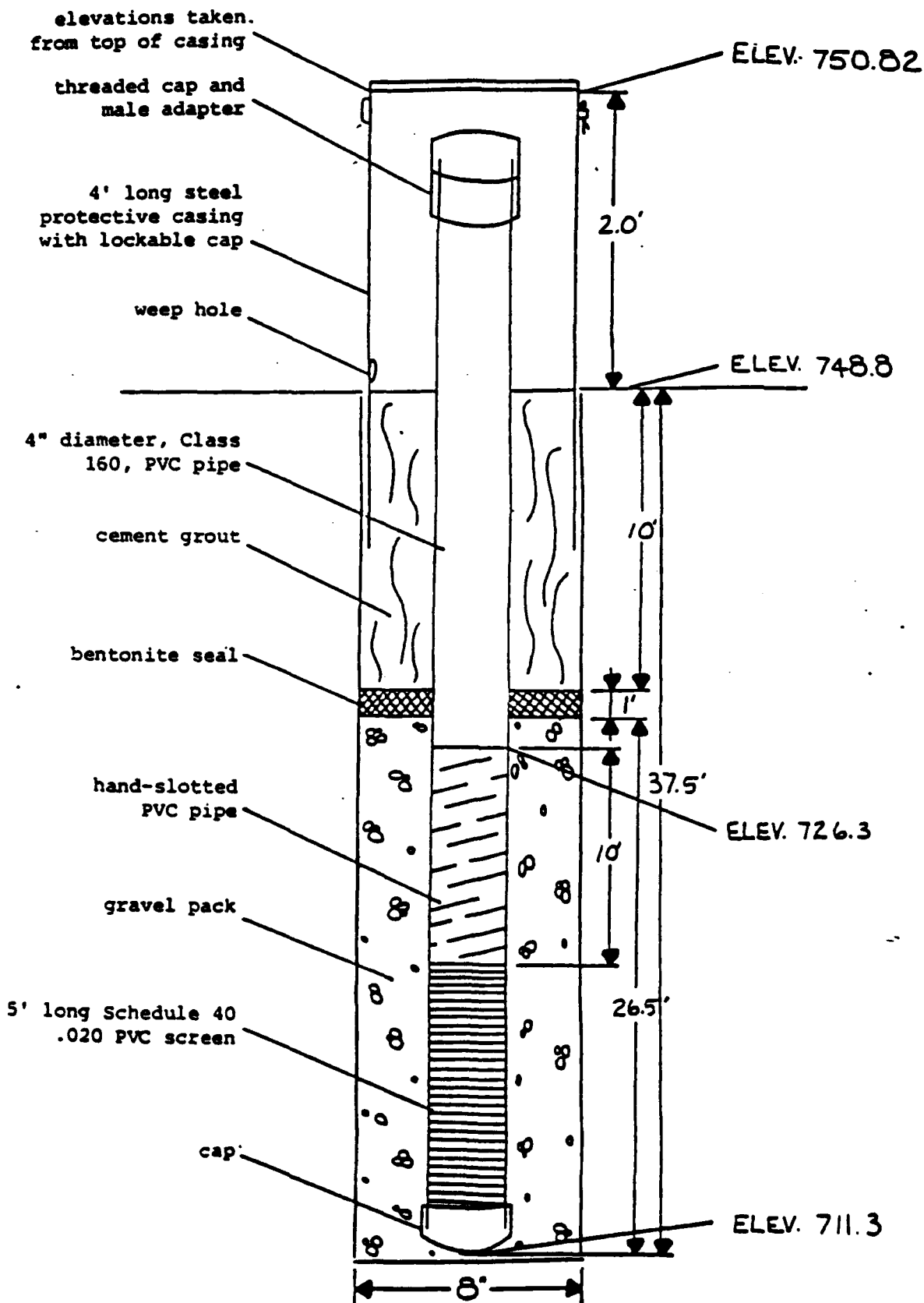
Water Level

Date _____

22'

Before
Pumping 1/25/82 (Completo

CONSTRUCTION OF WELL



MW 8-1

TEST BORING LOG

Project Lake City AAP Boring No. MW 8-1 Sheet 1 of 1
 Surface Elevation 748.8 Offset _____
 Date Started 8/18/81 Completed 8/18/81
 City & State Independence, Missouri Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wa
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger B

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	3.0'	WB				Dark brown silty clay, very stiff
3.0'	5.0'	WB				Brown silty clay, very stiff
5.0'	9.0'	WB				Same
9.0'	10.5'	ST1	2.75			Same
10.5'	12.5'	WB				Same
12.5'	15.0'	WB				Red brown silty clay, very stiff
15.0'	19.0'	WB				Same
19.0'	20.5'	ST2	2.5			Brown silty clay w/shale & trace sandstone, very stiff
20.5'	22.0'	WB				Same
22.0'	25.0'	WB				Gray silty clay, very stiff
25.0'	32.0'	WB				Gray fine sandy clay, very stiff
32.0'	37.0'	WB				Brown silty fine sand, med. dense
37.0'	40.0'	WB				Light brown silty clay, very stiff
40.0'	Total depth					

MARKS: (Casing Water Loss, Etc.)

Pumped 1-1/2 hour - 1-1/2 GPM

Static Water Level

9.9

Time

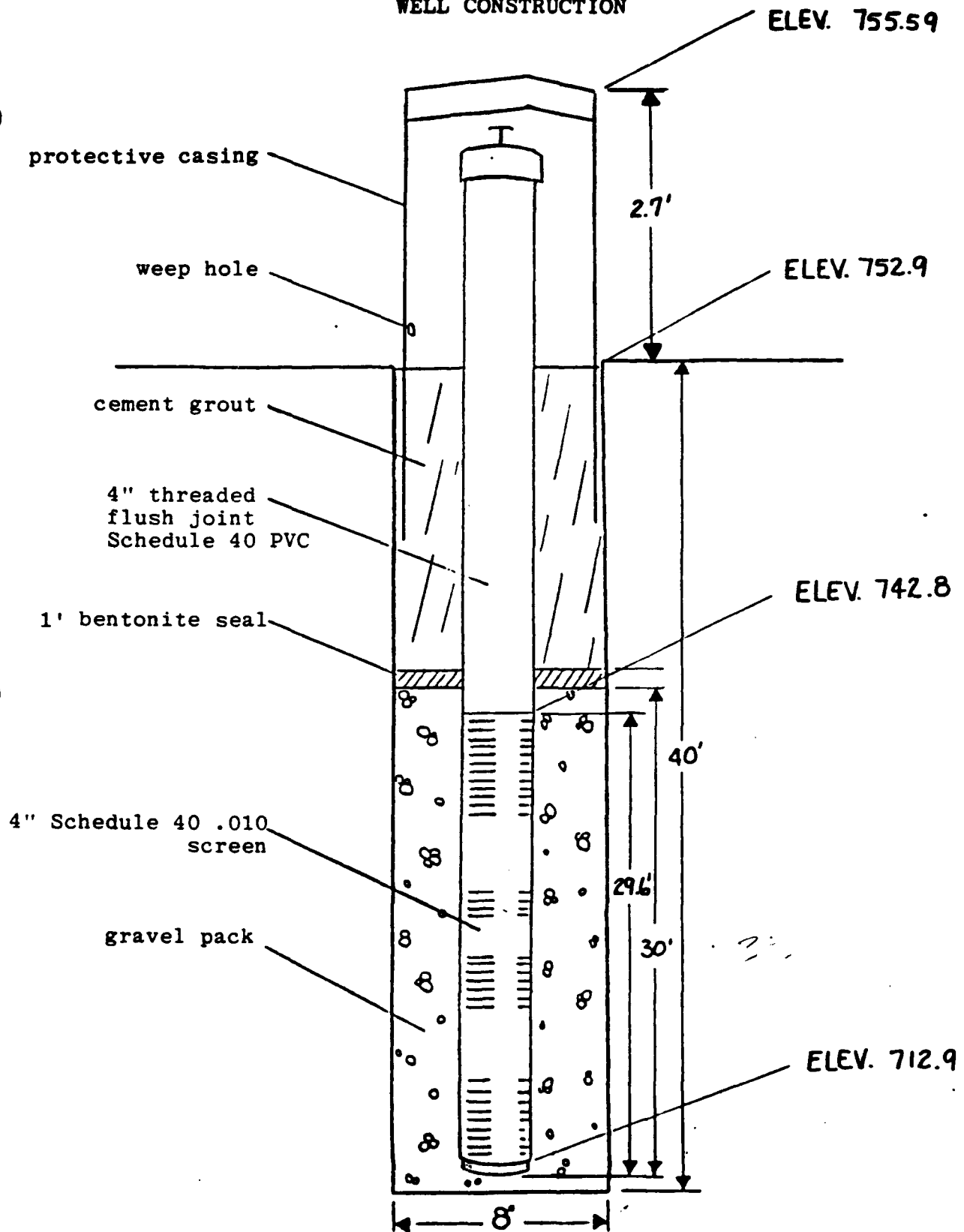
Date

9/14/81 (Comple

Wynne-Western Company, Inc.

C-251

WELL CONSTRUCTION



MW 8-2

TEST BORING LOG

Project Lake City A.A.P.

Boring No. 8-2 Sheet 1 of 1

replacement well

Surface Elevation 752.89 Offset 5' North of

Add _____

Date Started 9-25-84 Completed 9-26-84

City & State Independence, Missouri

Driller Buck Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETROMETER	NO OF BLOWS		
0.0	1.0	HA				Brown silty clay, moist, very stiff (
1.0	4.5	HA				Gray shale, dry, hard (FILL)
4.5	6.0	HA				Gray-brown silty clay, moist, very stiff (FILL)
6.0	8.5	HA				Gray-brown shale & clay, moist, very stiff (FILL)
8.5	9.8	HA				Gray-brown silty clay, moist, very stiff (FILL)
9.8	11.0	HA				Dark brown silty clay, moist, stiff
11.0	15.0	HA				Gray-brown silty clay, moist, stiff
15.0	17.0	ST-1	2.25		1.5	Same
17.0	18.0	HA				Same
18.0	28.0	HA				Dark gray brown silty clay, moist, st
28.0	35.0	HA				Dark gray very silty clay, very moist
35.0	37.0	ST-2	0.75		1.0	Same
37.0	40.0	HA				Same
40.0	Total	Depth				

MARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

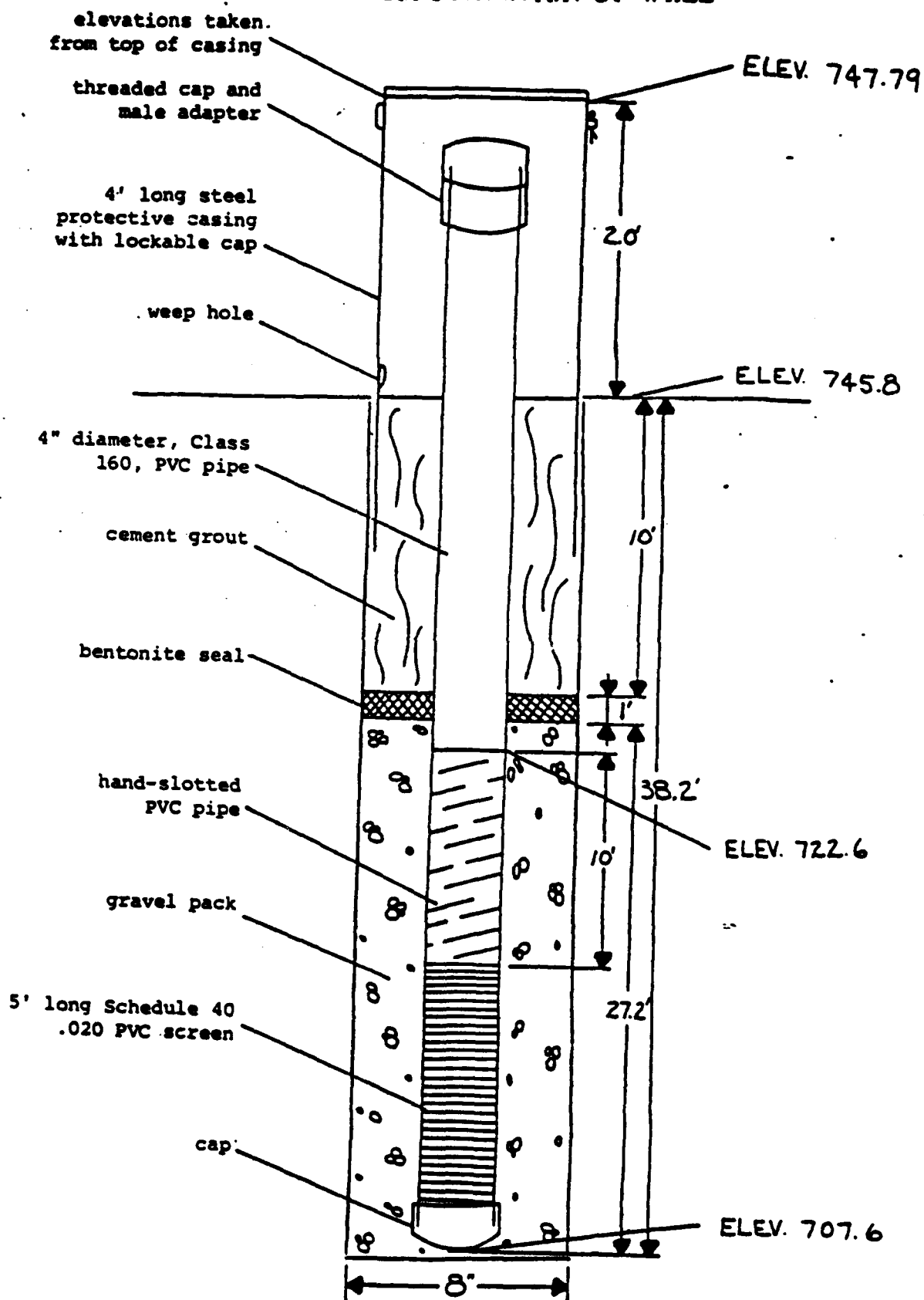
21.0'

9/26/84 (Completi

12.8'

1/17/85

CONSTRUCTION OF WELL



MW 8-2

TEST BORING LOG

Project Lake City AAP

Boring No. MW 8-2 Sheet 1 of 1

Surface Elevation 745.8 Offset _____

Address _____

Date Started 8/19/81 Completed 8/19/81

City & State Independence, Missouri

Driller B. Blank Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Dark gray silty clay, very stiff
5.0'	7.0'	WB				Same
7.0'	9.0'	WB				Gray & brown silty clay, very stiff
9.0'	10.5'	ST1	2.5			Same
10.5'	15.0'	WB				Same
15.0'	19.0'	WB				Same
19.0'	20.5'	ST2	2.25			Same
20.5'	23.0'	WB				Same
23.0'	25.0'	WB				Gray silty clay, very stiff
25.0'	30.0'	WB				Same
30.0'	32.0'	WB				Gray clayey fine sand, dense
32.0'	35.0'	WB				Gray silty clay w/trace fine sand, stiff
35.0'	40.0'	WB				Same
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Pumped 1-1/2 hour - 1-1/2 GPM

Static Water Level

7.4

Time

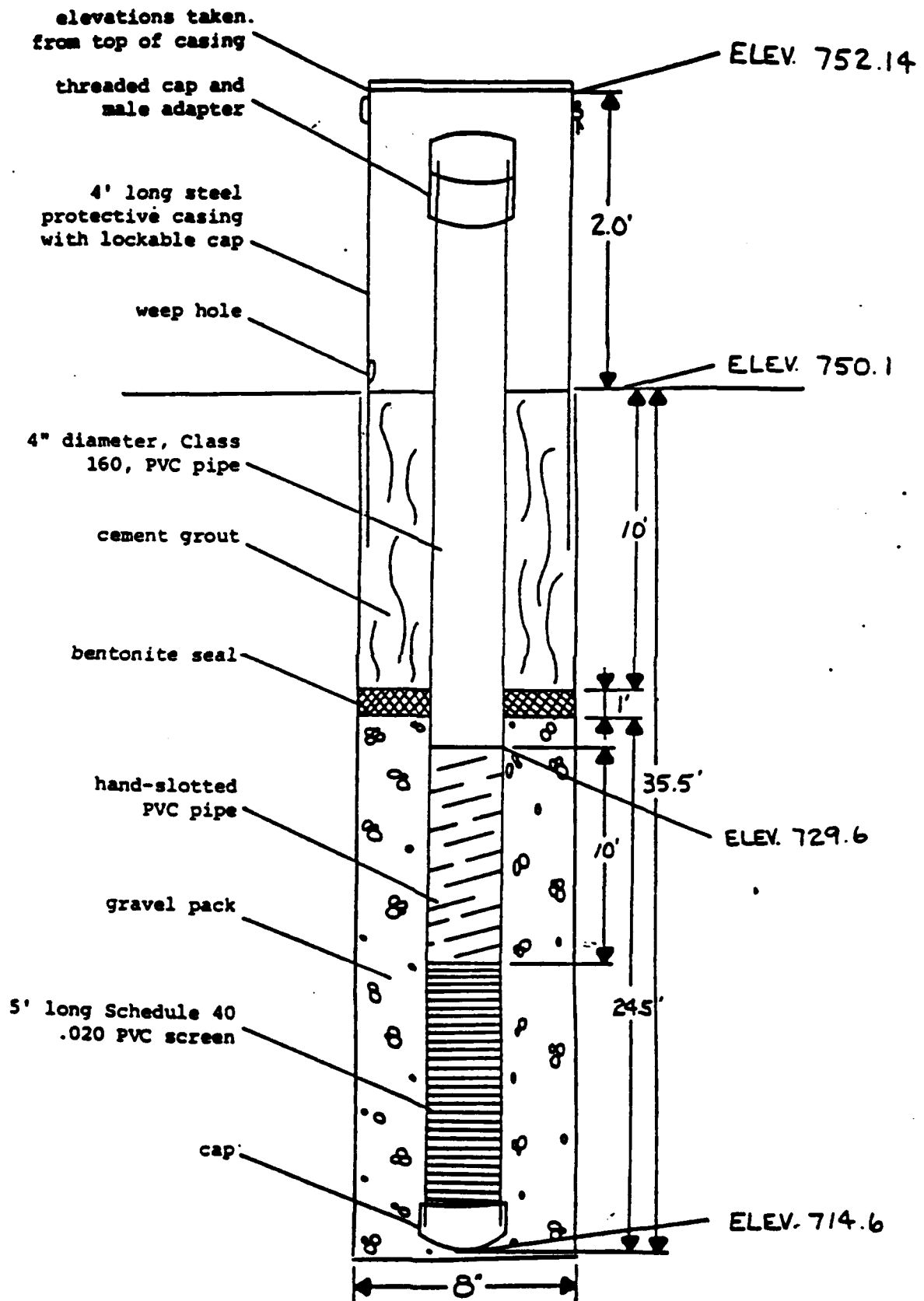
Date

9/14/81 (Completion)

Lynne-Western Company, Inc.

C-255

CONSTRUCTION OF WELL



MW 8-3

C-256

TEST BORING LOG

Project Lake City AAP

Boring No. MW 8-3 Sheet 1 of 1

Surface Elevation 750.1 Offset

Address

Date Started 8/20/81 Completed 8/20/81

City & State Independence, Missouri

Driller B. Blank Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core W
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core A
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	1.0'	WB				Topsoil
1.0'	5.0'	WB				Dark brown silty clay, very stiff
5.0'	7.0'	WB				Same
7.0'	9.0'	WB				Brown & gray silty clay, stiff
9.0'	10.5'	ST1	1.25			Same
10.5'	15.0'	WB				Same
15.0'	19.0'	WB				Same
19.0'	20.5'	ST2	1.5			Brown & gray silty clay w/trace sha stiff
20.5'	22.5'	WB				Same
22.5'	25.0'	WB				Maroon & olive & gray shale w/trace fine sand, very stiff
25.0'	30.0'	WB				Gray silty fine sand w/trace clay, very stiff
30.0'	33.5'	WB				Gray silty fine sand, dense
33.5'	35.0'	WB				Gray silty clay, very stiff
35.0'	40.0'	WB				Gray silty clay w/trace lignite, ver stiff
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Pumped 2 hours - 1 GPM

Static
Water Level

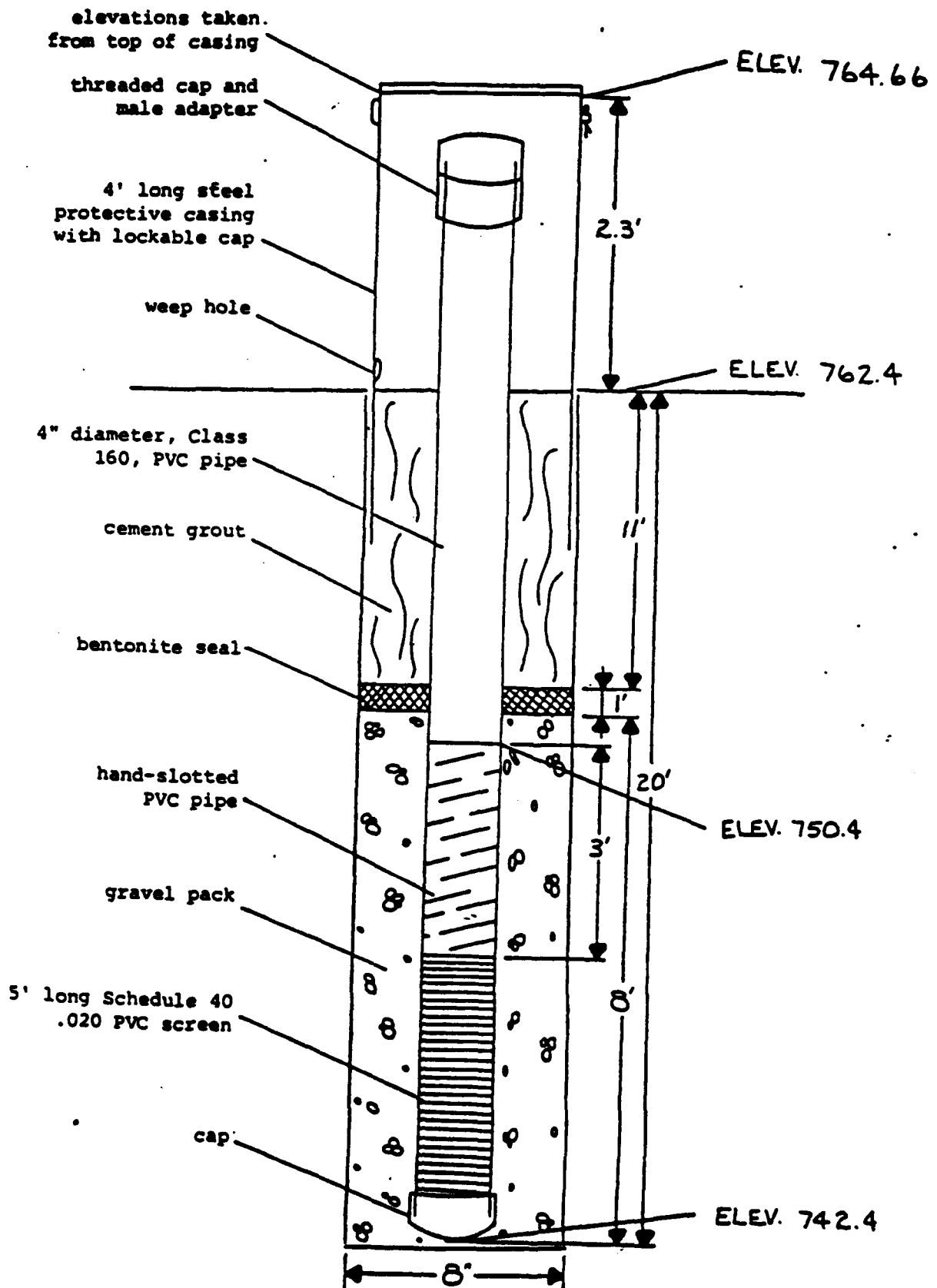
5.9

Time

Date

9/14/81 Completer

CONSTRUCTION OF WELL



MW 8-4

TEST BORING LOG

Project **Lake City AAP**

Boring No. MW 8-4 Sheet 1 of 1

Surface Elevation 762.4 Offset

Date Started 8/18/81 Completed 8/18/81

City & State Independence, Missouri

Driller T. Butler Rig

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core W
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core A
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger I

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION
FROM	TO		POCKET PENETROMETER	NO OF BLOWS		COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
0.0'	3.5'	WB				Light brown silty clay, med. to stiff
3.5'	6.0'	WB				Light gray silty clay w/trace sand, to med.
6.0'	8.5'	WB				Dark brown silty clay w/trace sand, to med.
8.5'	9.5'	WB				Green gray weathered shale, med. to stiff
9.5'	11.0'	SS1				Layered maroon & gray shaly clay, med. to stiff
11.0'	13.5'	WB				Same
13.5'	14.0'	WB				Light gray weathered shale, soft to med.
14.0'	16.0'	WB				Maroon and light gray shaly clay, soft to med.
16.0'	19.5'	WB				Green gray weathered shale, med. to hard
19.5'	40.0'	WB				Light gray shale, hard
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

Static Water Level

Time

Date _____

Speed 1-1/2 hour - 1/2 GPM

11.5

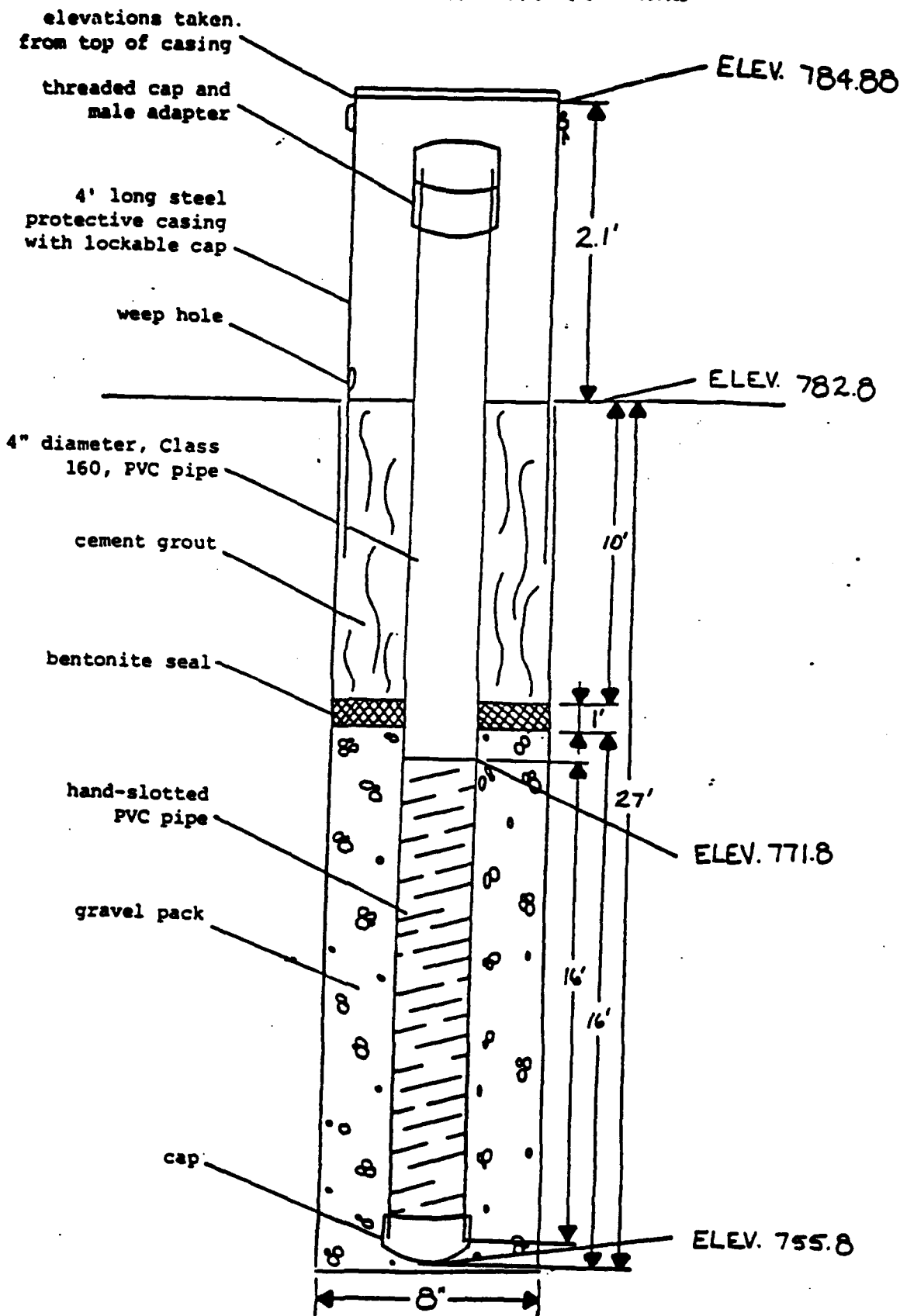
9/14/81 (Completion

Wyne-Western Company, Inc.

C-259

1. 44-38861

CONSTRUCTION OF WELL



MW 8-5

TEST BORING LOG

Project Lake City AAP
 City & State Independence, Missouri

Boring No. MW 8-5 Sheet 1 of 1
 Surface Elevation 782.8 Offset _____
 Date Started 9/1/81 Completed 9/2/81
 Driller T. Butler Rig _____

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wa
 H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
 W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger B

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO. METER	NO. OF BLOWS		
0.0'	4.5'	WB				Light brown silty clay, med. to stiff
4.5'	6.0'	WB				Brown silty clay, med to stiff
6.0'	9.5'	WB				Gray silty clay, med. to stiff
9.5'	11.0'	SS1				Gray sandy clay, med. to stiff
11.0'	14.0'	WB				Same
14.0'	16.0'	WB				Light tan silty clay, soft to med.
16.0'	24.0'	WB				Dark gray sandy shale, med. to hard
24.0'	27.0'	WB				Light gray shale, soft to med.
27.0'	29.5'	WB				Gray shale, med. to hard
29.5'	34.0'	WB				Maroon shale, soft to med.
34.0'	36.5'	WB				Light gray shale, soft to med.
36.5'	40.0'	WB				Gray shale, med. to hard
40.0'	Total depth					

MARKS: (Casing, Water Loss, Etc.)

umped 2 hours - 1/2 GPM

Static
Water Level

15.9

Time

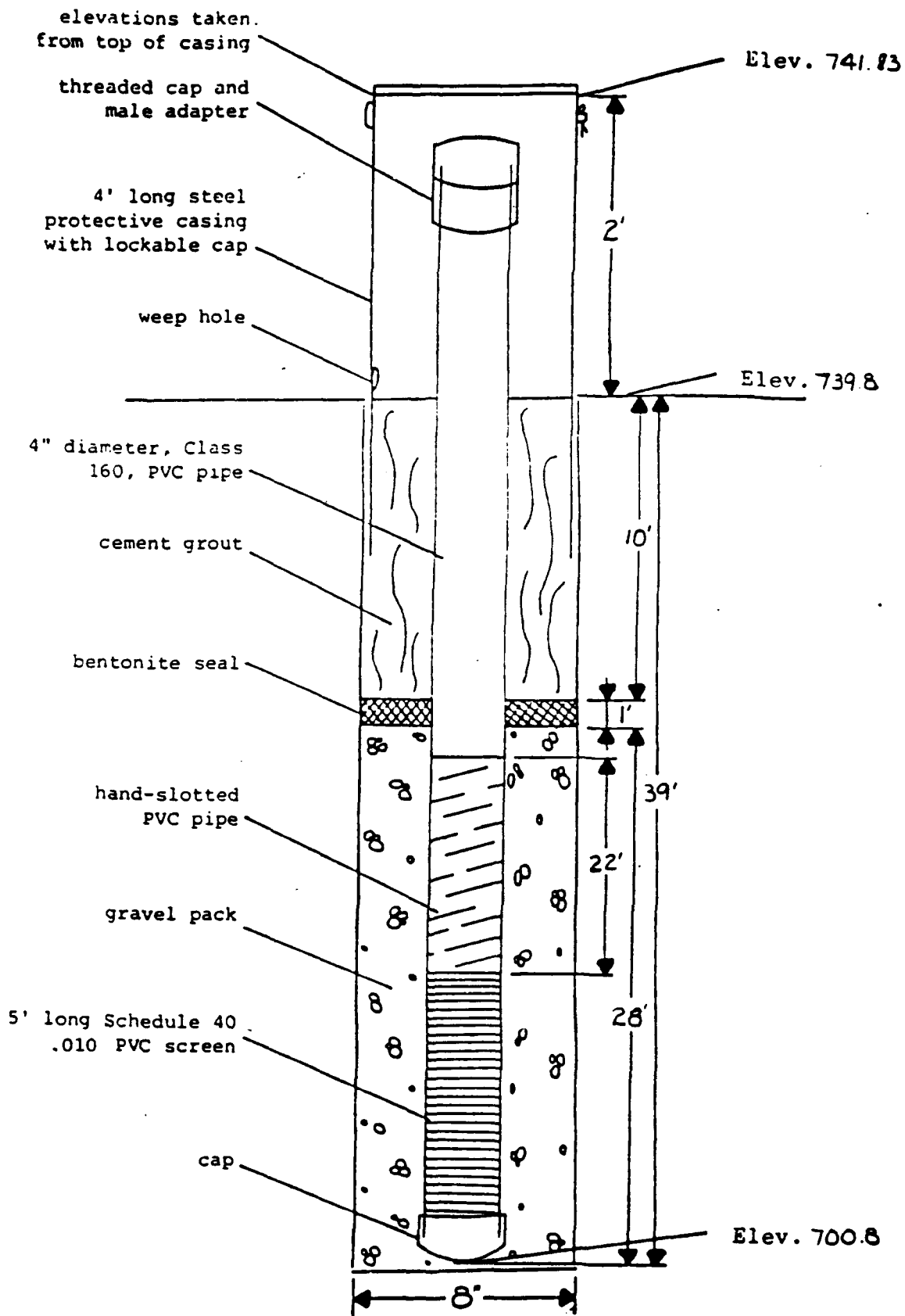
Date

9/14/81

(Completion)

Wynne-Western Company, Inc.

C-261



MW 9-1

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 9-1 Sheet 1 of 1

Surface Elevation 739.83 Offset

Date Started 12/2/81 Completed 12/2/81

ss Independence, Missouri

City & State Independence, Missouri

Driller J. Von Holt Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wa
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger B

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

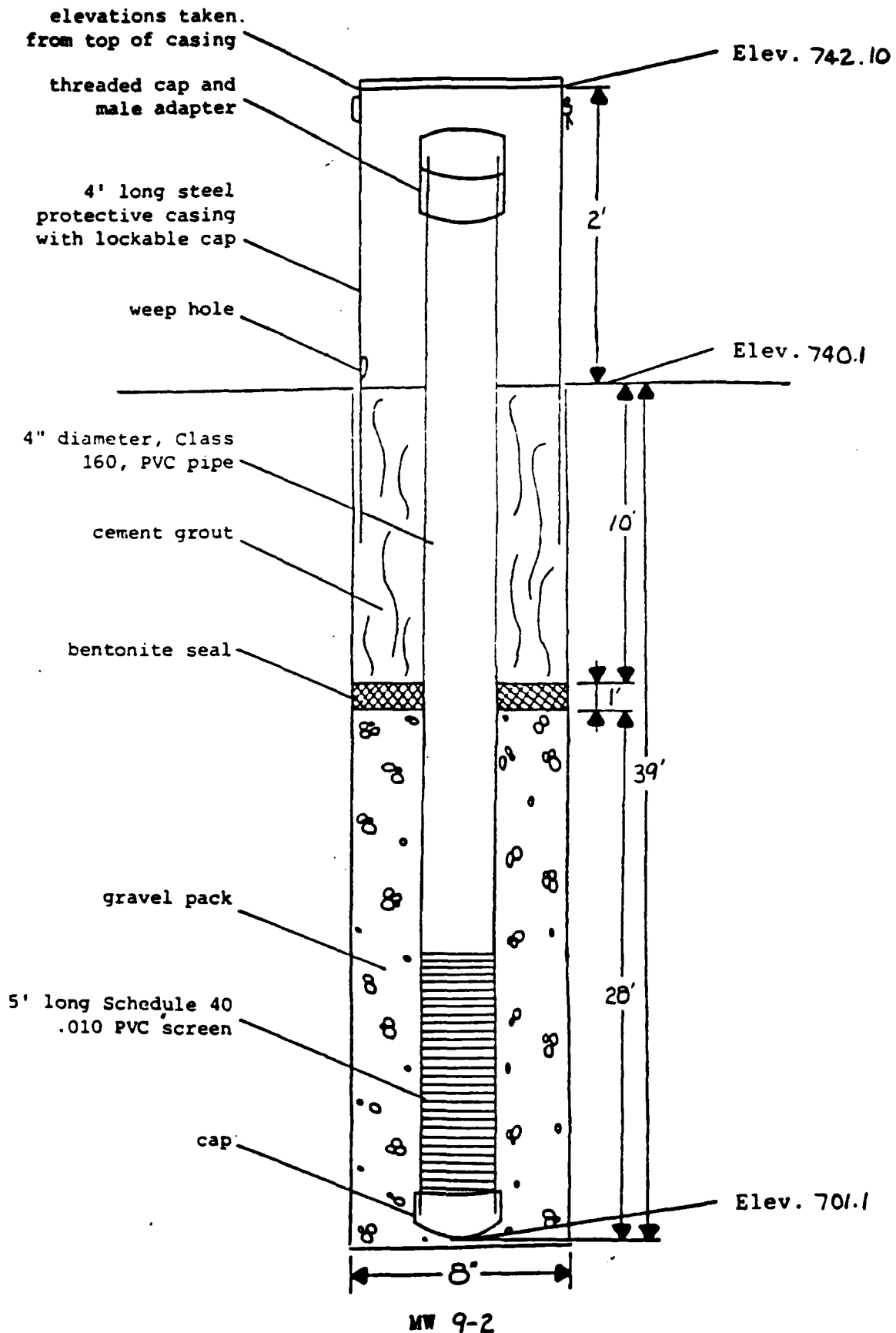
Sample of Sand @ 34' - 40'

12.45

1/28/82 (Completion

Pumped for 2.5 hours @ 6 GPM

CONSTRUCTION OF WELL



TEST BORING LOG .

Project Lake City Army Ammunition Plant

Boring No. MW 9-2

Sheet 1 of 1

Surface Elevation 740.10

Offset _____

ADDRESS

Date Started 12/9/81

Completed 12/9/81

City & State Independence, Missouri

Driller T. J. Butler

Rig D-2

Abbreviations:

A.O. - Auger Only

R.B. - Rock Bit

C.W. - Core Wa

H.A. - Hollow Auger

S.S. - Split Spoon

C.A. - Core Air

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date _____

Ag sample of sand 32.5' - 40.0'

15.40

1/29/82 (Compl)

Pumped for 1 hour @ 5 GPM

Wayne-Western Company, Inc.

C-266

CONSTRUCTION OF WELL

elevations taken
from top of casing

threaded cap and
male adapter

4' long steel
protective casing
with lockable cap

weep hole

4" diameter, Class
160, PVC pipe

cement grout

bentonite seal

hand-slotted
PVC pipe

gravel pack

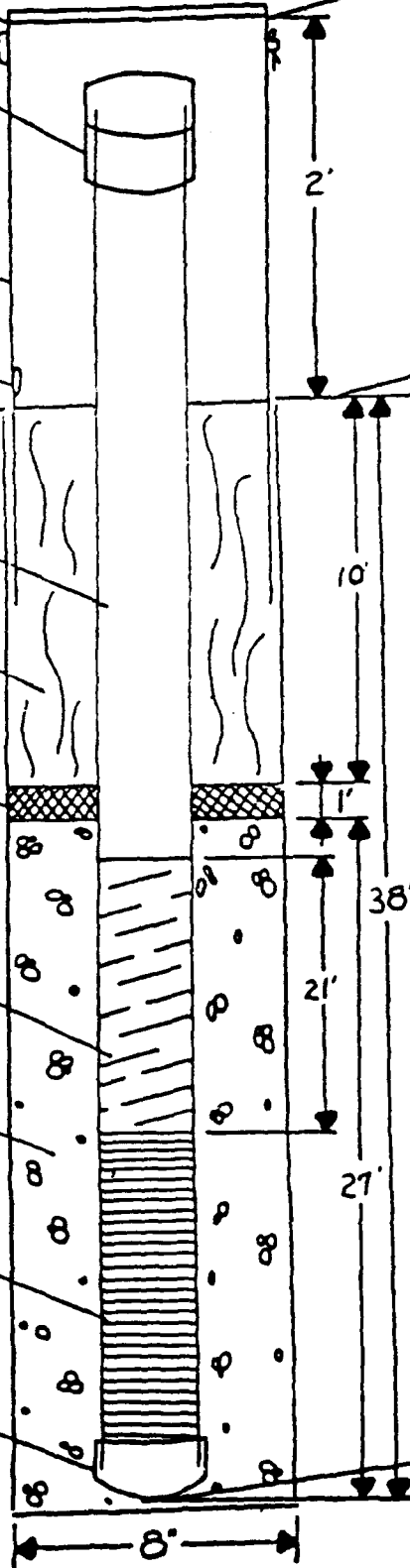
5' long Schedule 40
.010 PVC screen

cap

Elev. 741.43

Elev. 739.4

Elev. 701.4



MW 9-3

TEST BORING LOG

of Lake City Army Ammunition Plant

Boring No. MW 9-3 Sheet 1 of 1

Surface Elevation 739.43 Offset

Address _____

Date Started 12/3/81 Completed 12/3/81

City & State Independence, MissouriDriller J. Von Holt Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

REMARKS: (Casing Water Loss, Etc.)

Water Level

Time

Date

Bag Sample of Sand @ 33' - 40'

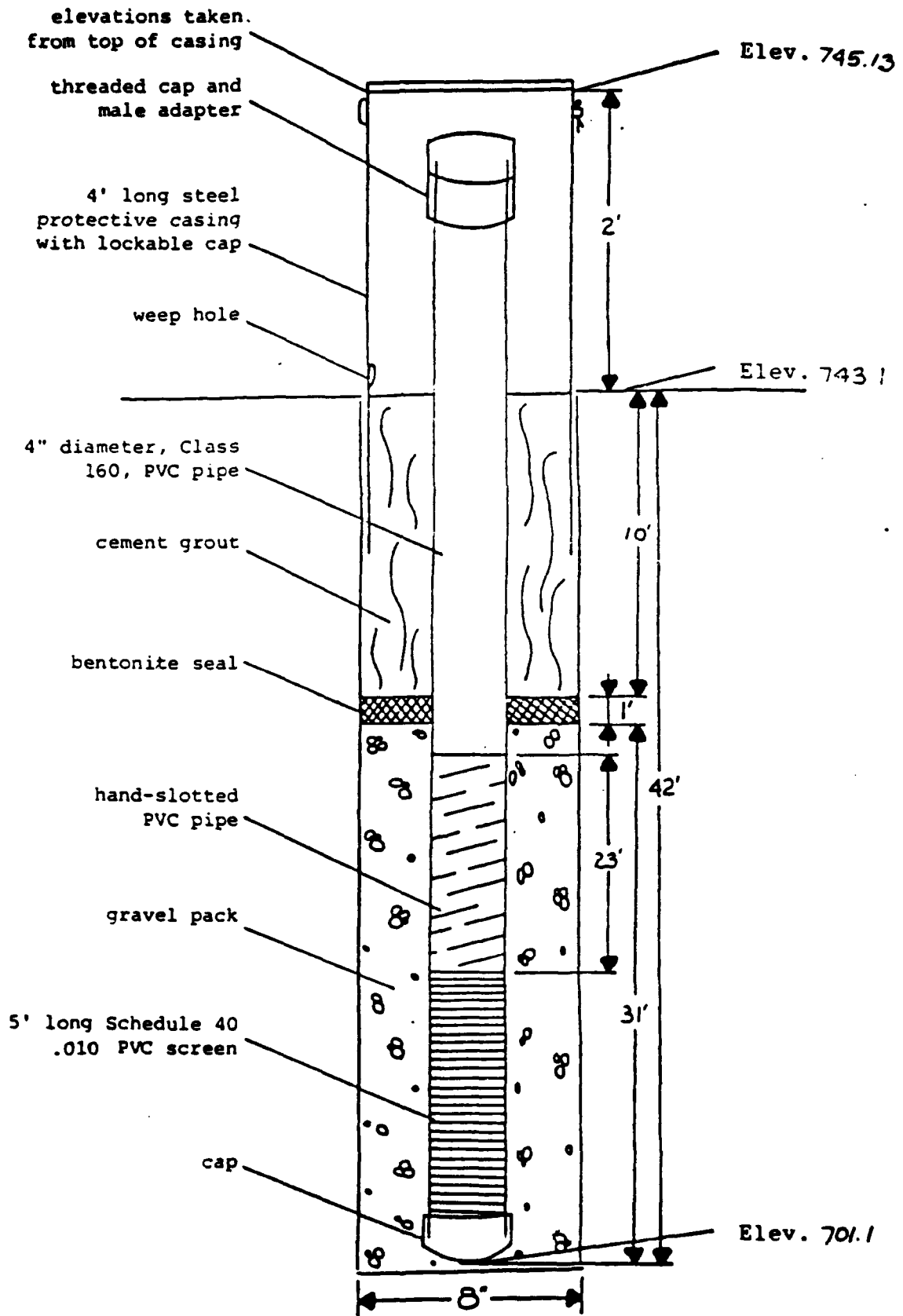
1130

1/28/82 iComple

Pumped for 3 hours @ 6 GPM

C-268

CONSTRUCTION OF WELL



MW 9-4

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 9-4

Sheet 1 of 1

Surface Elevation 743.03

Offset

Date Started 12/4/81

Completed 12/4/81

City & State Independence, Missouri

Driller J. Von Holt

Rig D-2

Abbreviations:

A.O. - Auger Only

R.B. — Rock Bit

C.W. - Core W₂

H.A. - Hollow Auger

S.S. - Split Spoon

C.A. - Core A7

W.B. - Wash Bone

S.T. - Shelby Tube

F.B. - Finger 1

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Data

bag sample of sand @36' - 40.'

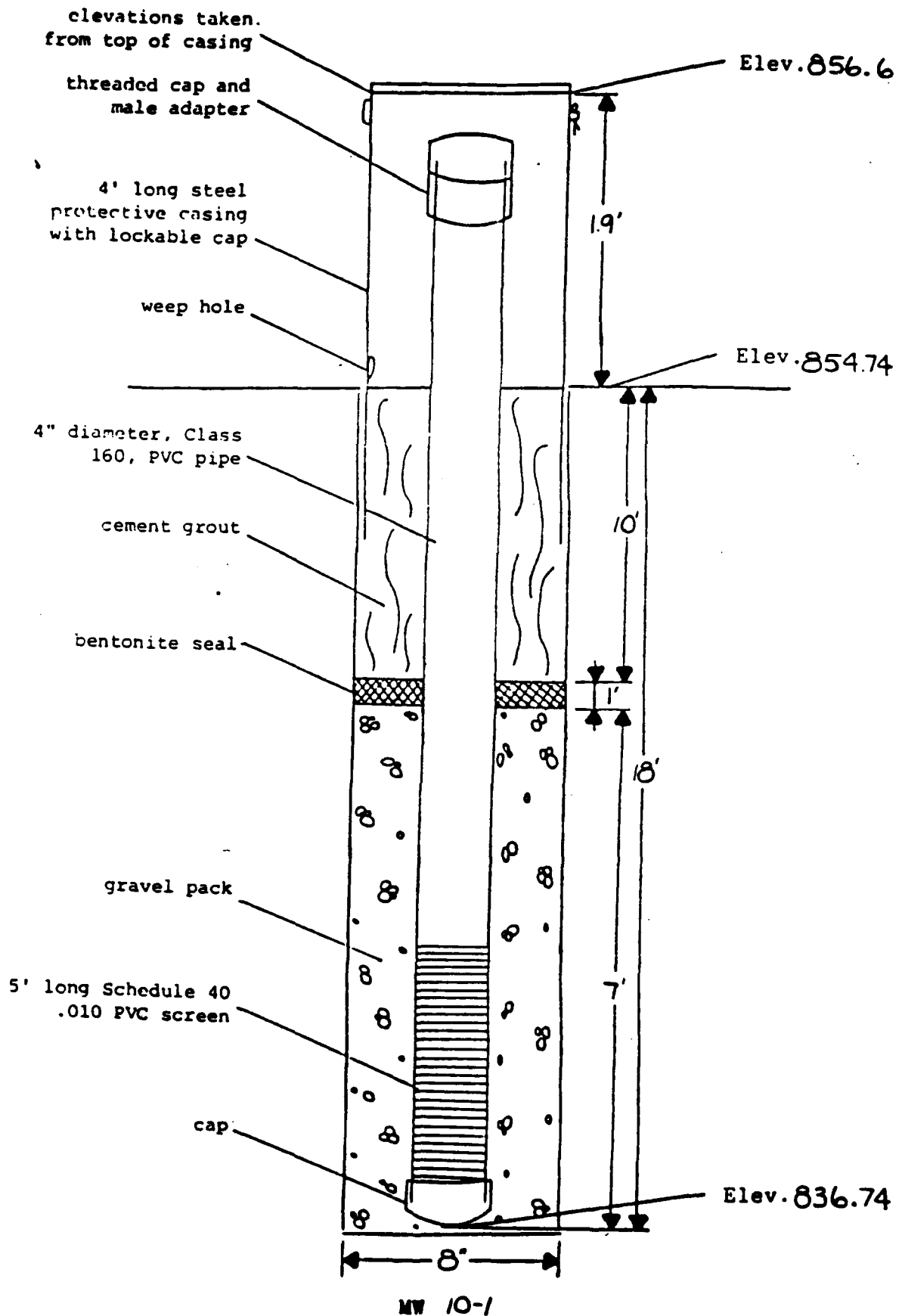
12.55

1/28/82 (Compl)

Pumped for 2.5 hours @ 6 GPM

C-270

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 10-1 Sheet 1 of

Surface Elevation 854.74 Offset 10' E. of 10

Address

Date Started 1/8/82 Completed 1/8/82

City & State Independence, Missouri

Driller T. Butler Rig D-2

Abbreviations:

A.O. - Auger Only	R.B. - Rock Bit	C.W. - Core Wat
H.A. - Hollow Auger	S.S. - Split Spoon	C.A. - Core Air
W.B. - Wash Bore	S.T. - Shelby Tube	F.B. - Finger Bi

[illegible]

MARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

(Complete)

4.25

2/15/82

Wayne-Western Company, Inc.

C-272

TEST BORING LOG

object Lake City Army Ammunition Plant

Boring No. 10-1

Sheet 1 of 1

Surface Elevation

Offset

Address

Date Started 1/4/82

Completed 1/4/82

ty & State Independence, Missouri

Driller T. Butler

Rig D-2

Abbreviations:

A.O. - Auger Only

R.B. - Rock Bit

C.W. - Core Water

H.A. - Hollow Auger

S.S. — Split Spoon

C.A. - Core Air

W.B. - Wash Bore

S.T. - Shelby Tube

F.B. - Finger Bit

[illegible]

E AKS: (Casing Water Loss, Etc.)

Water Level

Time

Date

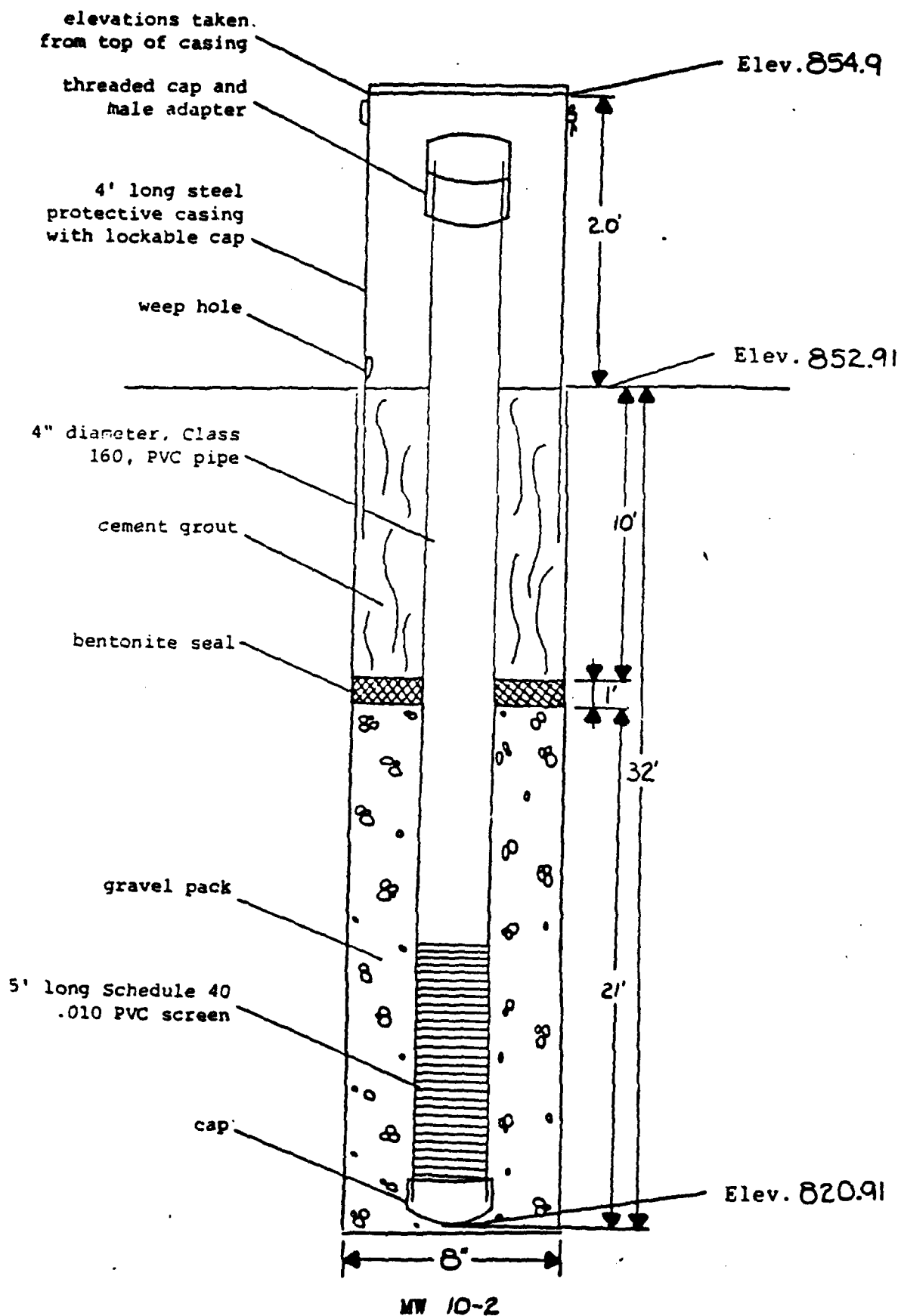
16.0

1:30 pm

1/4/82

(Completion

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. **10-2**

Sheet 1 of

[illegible]

address

Date Started 1/4/82 Completed 1/4/82

City & State Independence, Missouri

Driller T. Butler Rig D-2

Abbreviations:

A.O. - Auger Only	R.B. - Rock Bit	C.W. - Core War
H.A. - Hollow Auger	S.S. - Split Spoon	C.A. - Core Air
W.B. - Wash Bore	S.T. - Shelby Tube	F.B. - Finger Bi

[illegible]**REMARKS:** (Casing, Water Loss, Etc.)

Water Level

Time

Date

Dry

12:15 pm

1/4/82 (Con

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 10-2

Sheet Lot

Surface Elevation 852.91 Offset 5' E. of 10-

Date Started 1/9/82 **Completed** 1/9/82

City & State **Independence, Missouri**

Driller T. Butler

Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wz
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core A
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger E

[illegible]

MARKS: (Casing, Water Loss, Etc.)

Water Level

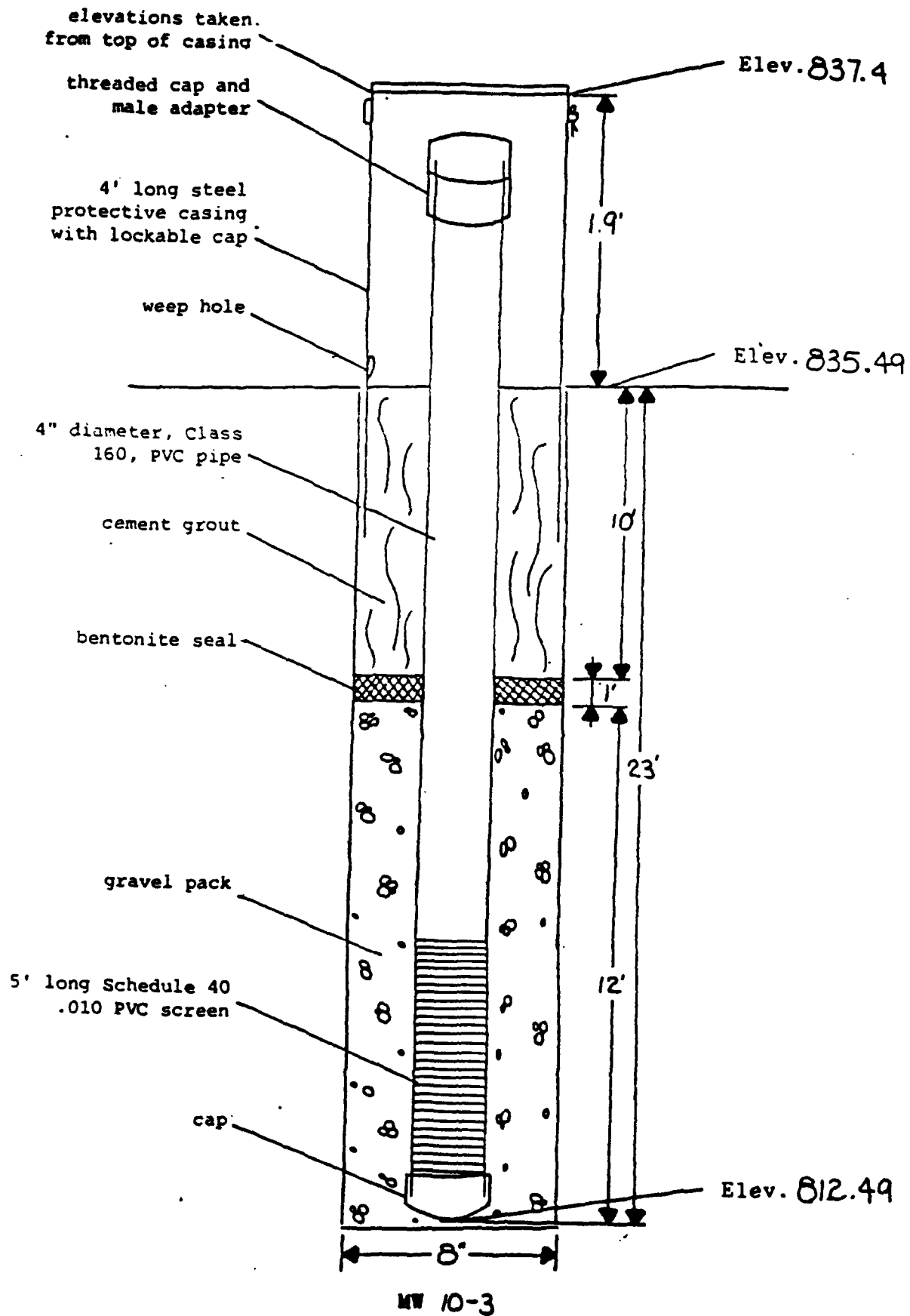
Time

Date _____

16-25

2/15/82 (Complex)

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 10-3

Sheet 1 of

Surface Elevation 835.49 Offset

Date Started 1/4/82 Completed 1/4/82

Driller T. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wire
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Used auger hole as pilot hole for well.

On 1/7/82 WB hole for monitoring well with a

TD of 23'

Water Level

Time

Date _____

Dry

3:00 pm

1/4/82 (Comp

20.35

2/15/82

elevations taken.
from top of casing'



TEST BORING LOG

Subject Lake City Army Ammunition Plant

Boring No. MW 10-4 Sheet 1 of 1

Surface Elevation 842.12 Offset

Idr _____ Date Started 1/4/82 Completed 1/4/82

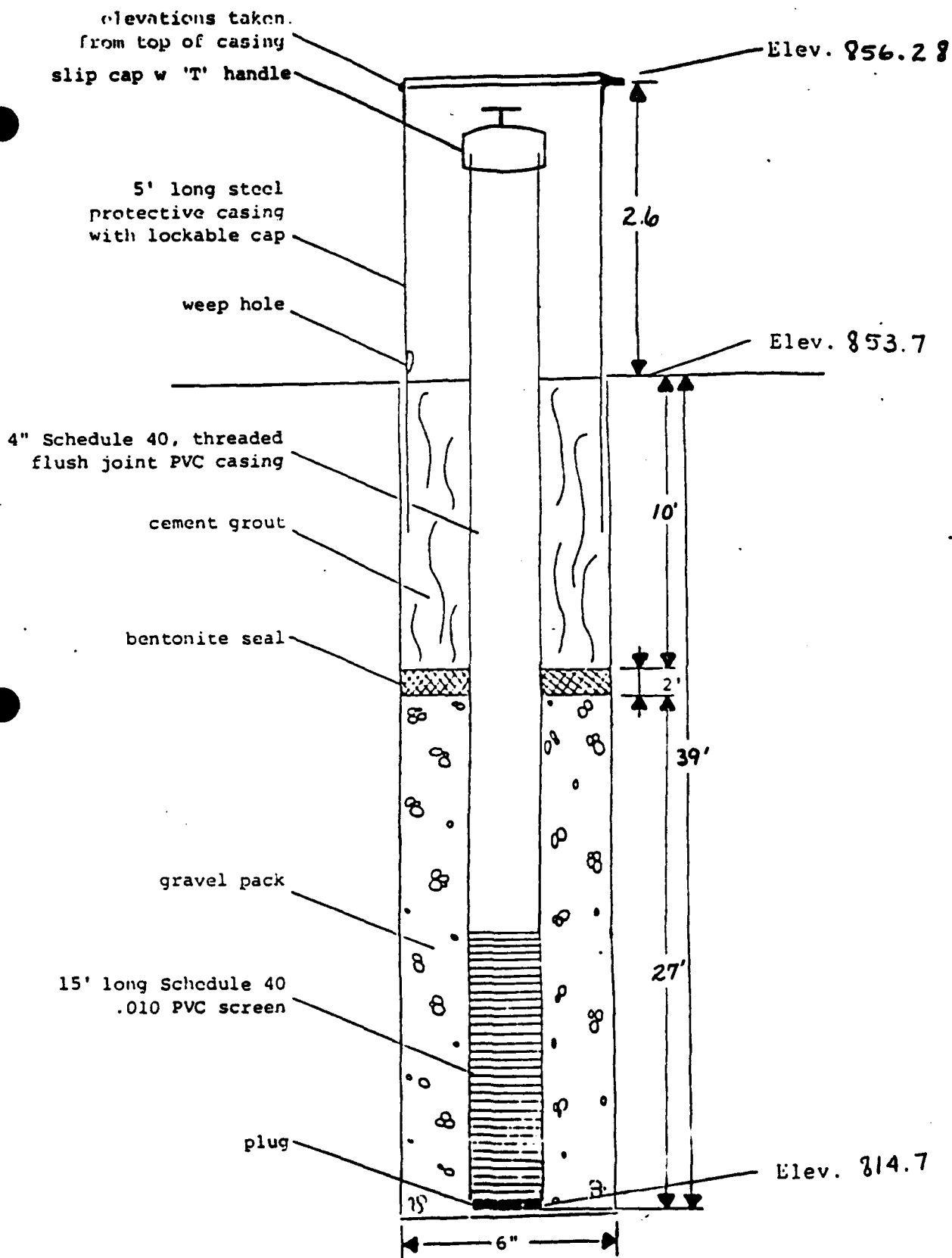
City & State Independence, Missouri Driller T. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

11.	DATE	TIME	DAY
with a	24.0	2:00 pm	1/4/82 (Complete
	8.1		2/15/82

WELL CONSTRUCTION



MW 10-5

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 10-5 Sheet 1 of 1

Surface Elevation 829.4 Offset

Date Started 1/5/83 **Completed** 1/6/83

City & State Independence, Missouri

Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**REMARKS: (Casing, Water Loss, Etc.)**

Water Level

Time

Date _____

Dry

3:00pm

1/5/83

(Completion

WELL CONSTRUCTION

elevations taken
from top of casing
slip cap w 'T' handle

5' long steel
protective casing
with lockable cap

weep hole

4" Schedule 40, threaded
flush joint PVC casing

cement grout

bentonite seal

gravel pack

15' long Schedule 40
.010 PVC screen

plug

Elev. 831.98

Elev. 829.4

Elev. 805.9

2.6

5'

2'

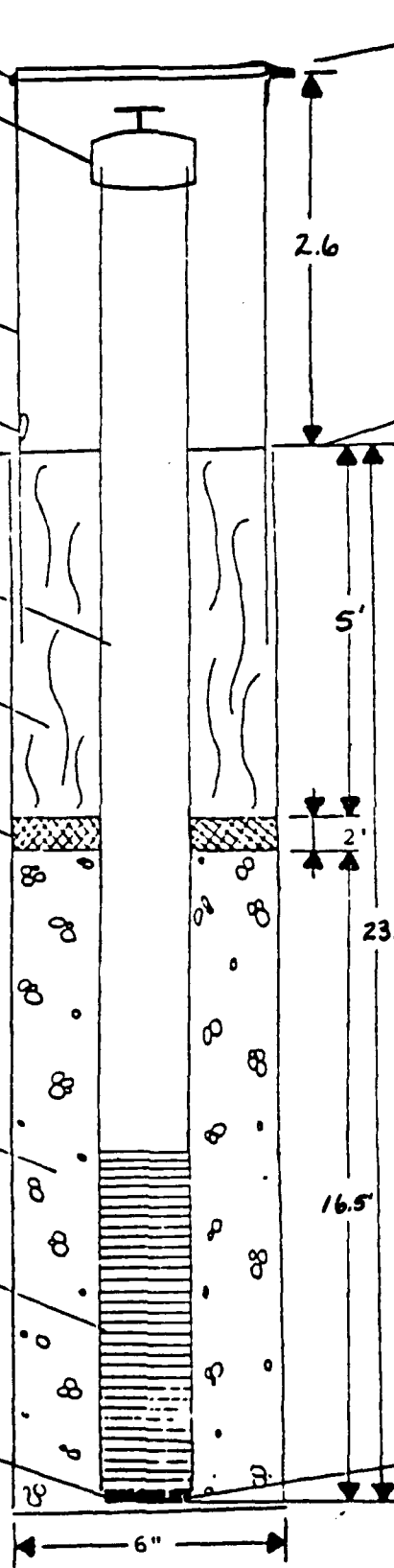
23.5'

16.5'

6"

MW 10-6

C-283



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 10-6 Sheet 1 of 1

Surface Elevation 853.7 Offset

Date Started 1/5/83 Completed 1/5/83

City & State Independence, Missouri

Driller B. Blank Rig AD-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]**MARKS: (Casing, Water Loss, Etc.)**

Water Level

Time

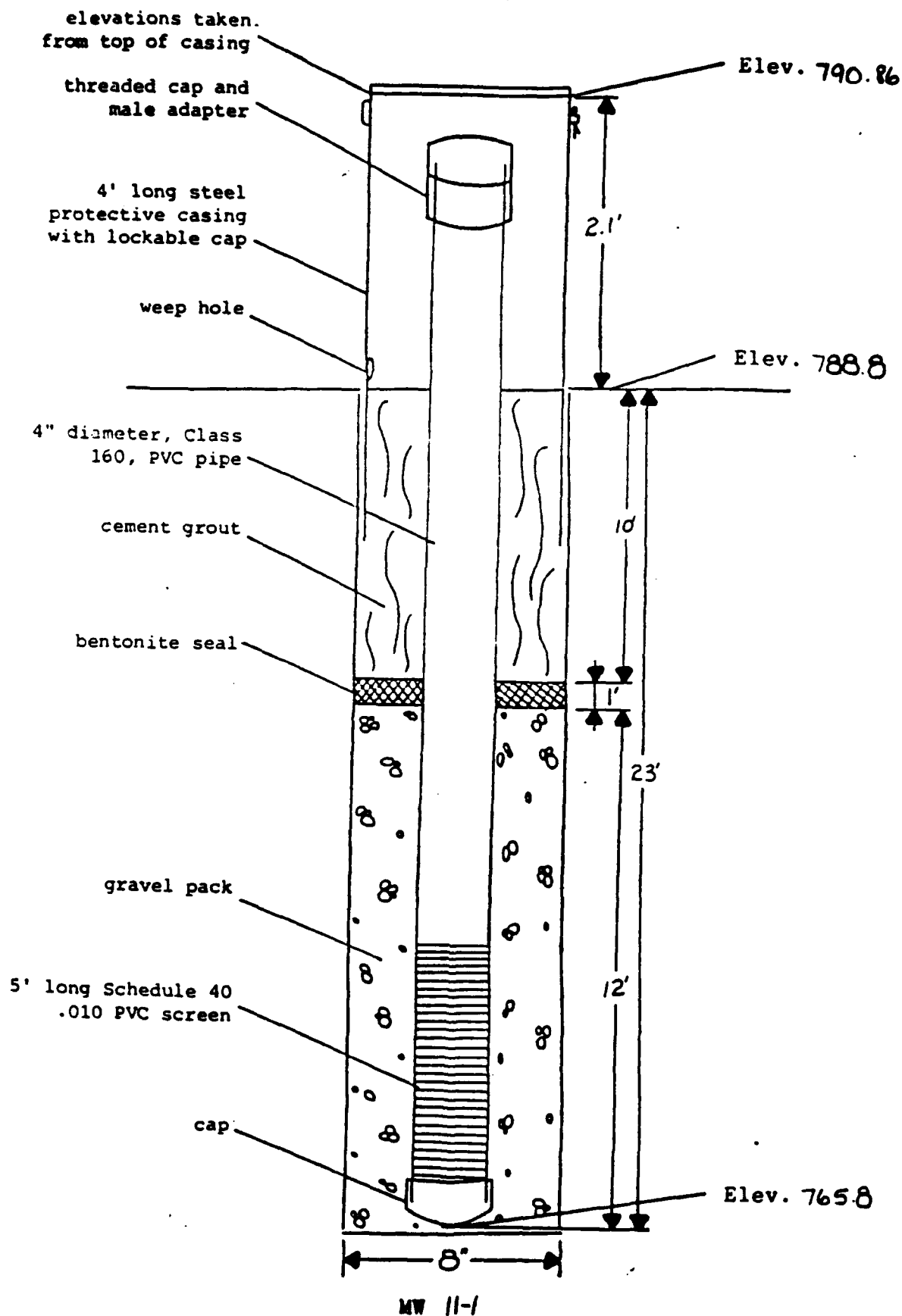
Date

10.0

12:10pm

1/5/83

(Completion



TEST BORING LOG

Subject Lake City Army Ammunition Plant

Boring No. MW 11-1 Sheet 1 of 1

Surface Elevation 788.76 Offset

3dr

Date Started 12/14/81 Completed 12/14/81

ty & State Independence, Missouri

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date _____

~~Pumped for 2 hours. Pumped 1/2 GPM. not steadily~~

9.7

1/28/82 (Completion)

TEST BORING LOG

1 Lake City Army Ammunition Plant

Boring No. 11-1

Sheet 1 of 1

Surface Elevation _____ Offset _____

Date Started 12/9/81 Completed 12/9/81

& State Independence, Missouri

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

RE .AKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

~~On pulling augers, heard water bubbling in hole, probably a pocket of methane gas. Checked after 30 minutes, it had stopped.~~

22

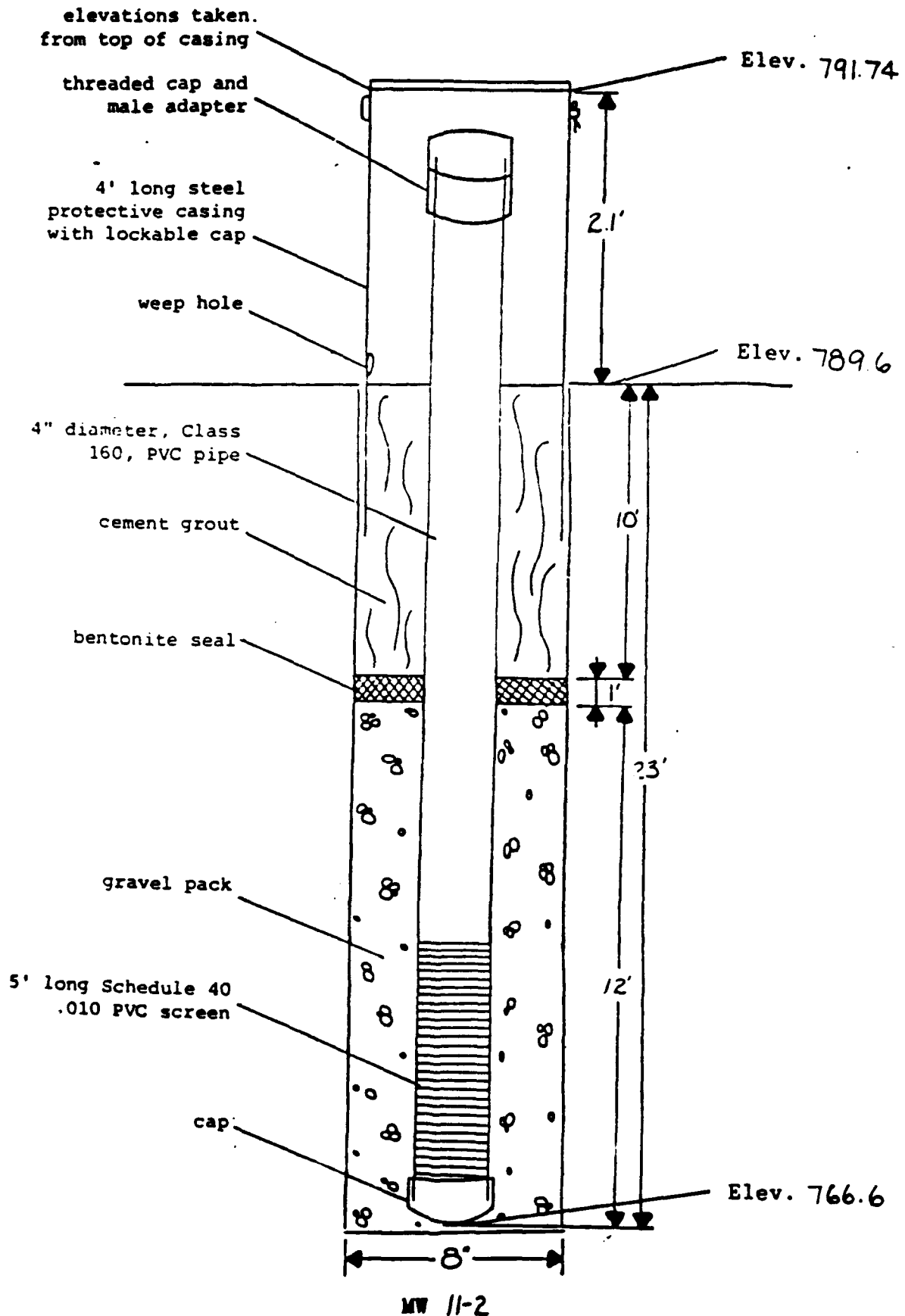
8:30 am

12/9/81 (Complectic

Wayne-Western Company, Inc.

C-287

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 11-2 Sheet 1 of 1

Address _____

Surface Elevation 789.64 Offset 10' W of 11-2

Date Started 12/15/81 Completed 12/15/81

City & State Independence, Missouri

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date _____

Pumped for 1.5 hours, Pumped 3 GPM steadily

62

1/28/82 (Comple

1

1

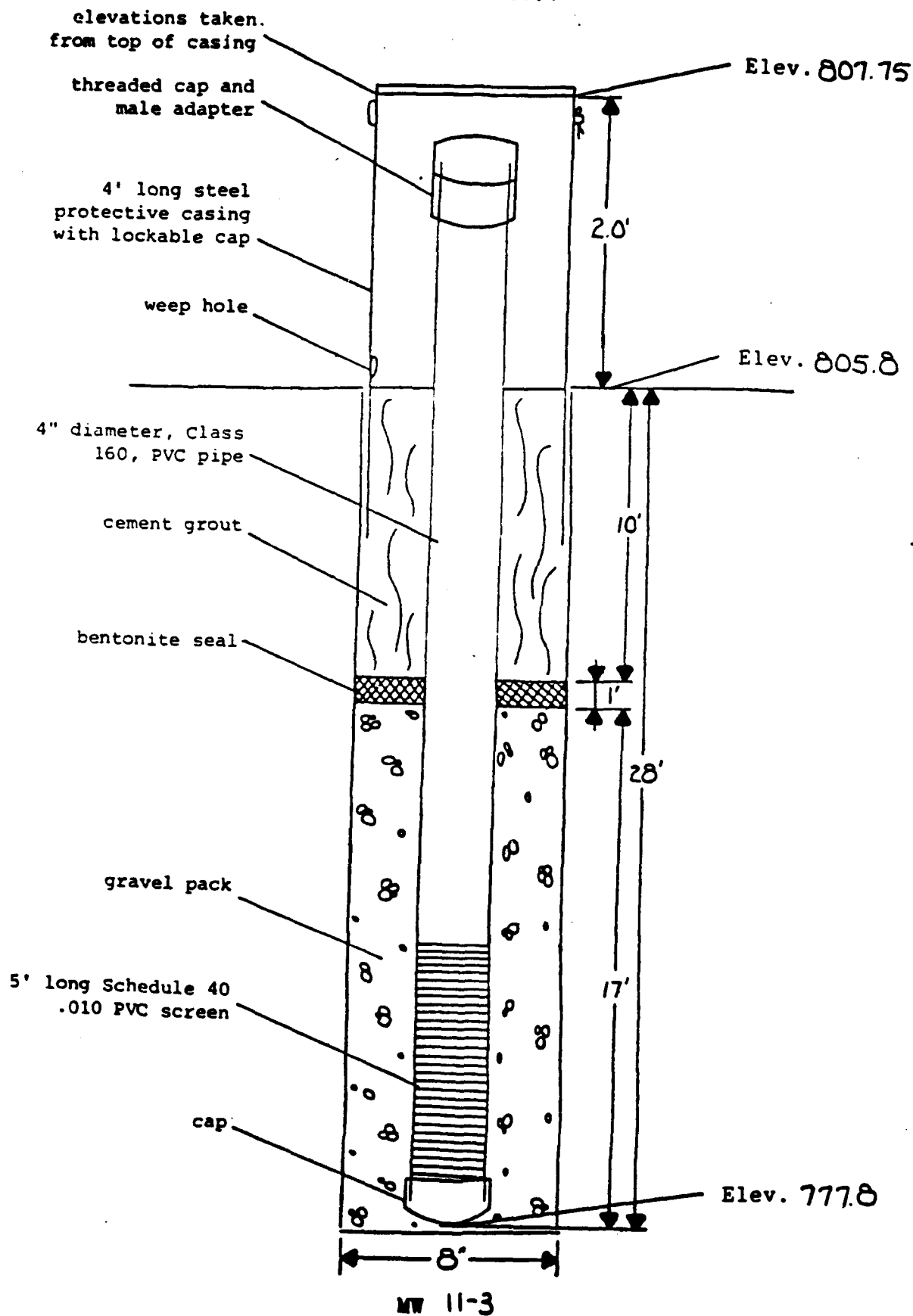
Driller T. J. Butler Rig D-2

1

1

Data

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 11-3

Sheet 1 of 1

Surface Elevation 805.74 Offset

Date Started 1/13/82 Completed 1/14/82

Address

City & State Independence, Missouri

Driller T. Butler Rig D-2

Abbreviations:

A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wg
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger 3

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETRO-METER	NO. OF BLOWS		
0.0'	0.5'	WB				Topsoil
0.5'	5.0'	WB				Dark brown silty clay, med. to soft
5.0'	10.0'	WB				Same
10.0'	15.0'	WB				Same
15.0'	17.5'	WB				Same
17.5'	20.0'	WB				Light brown silty clay, soft to med.
20.0'	25.0'	WB				Same
25.0'	26.5'	WB				Same
26.5'	27.5'	WB				Brown shaly clay, med. to stiff
27.5'	35.0'	WB				Gray shale, stiff to med.
35.0'	36.5'	WB				Gray shale, very stiff to hard
36.5'	40.0'	WB				Light gray shale, hard to very stiff
40.0'	Total depth					

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

10.6

1/28/82 (Complete)

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. 11-3 Sheet 1 of 1

Surface Elevation _____ Offset _____

Address _____

Date Started 12/9/81 Completed 12/9/81

City & State Independence, Missouri

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Fing

[illegible]

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date _____

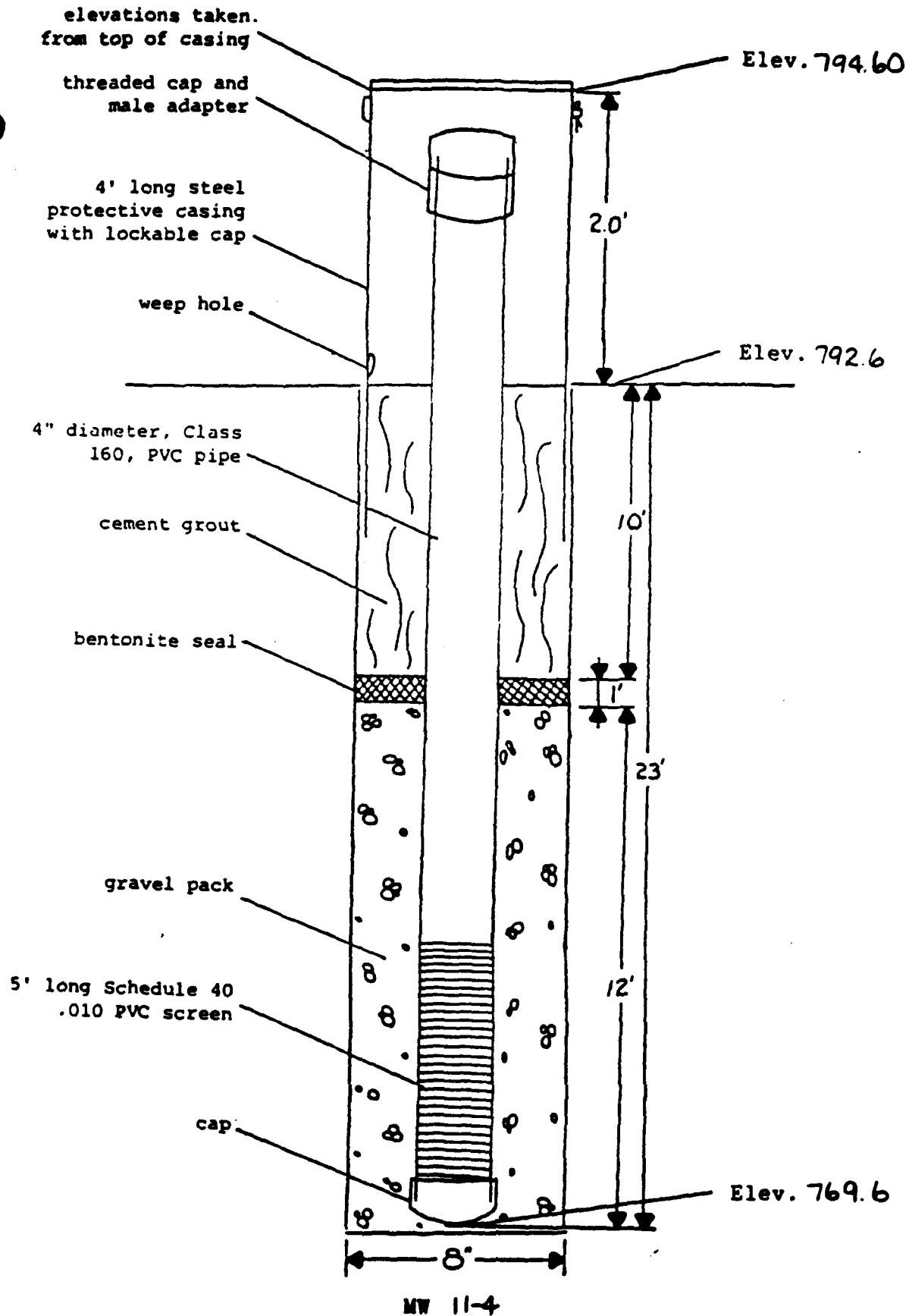
Location abandoned as no water present

Dry

12:00pm

12/9/81 (Cor

CONSTRUCTION OF WELL



TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. MW 11-4 Sheet 1 of 1

Surface Elevation 792.60 Offset 5' W of 11-4

Date Started 1/12/82 Completed 1/12/82

City & State Independence, Missouri

Driller T. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wire
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

MARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date _____

4.2

1/28/82 (Compl)

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. 11-4

Sheet 1 of

Surface Elevation	Offset
-------------------	--------

Address

Date Started 12/9/81 Completed 12/9/81

City & State Independence, Missouri

Driller T. J. Butler Rig D-2

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wa
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger B

[illegible]

REMARKS: (Casing Water Loss, Etc.)

Water Level

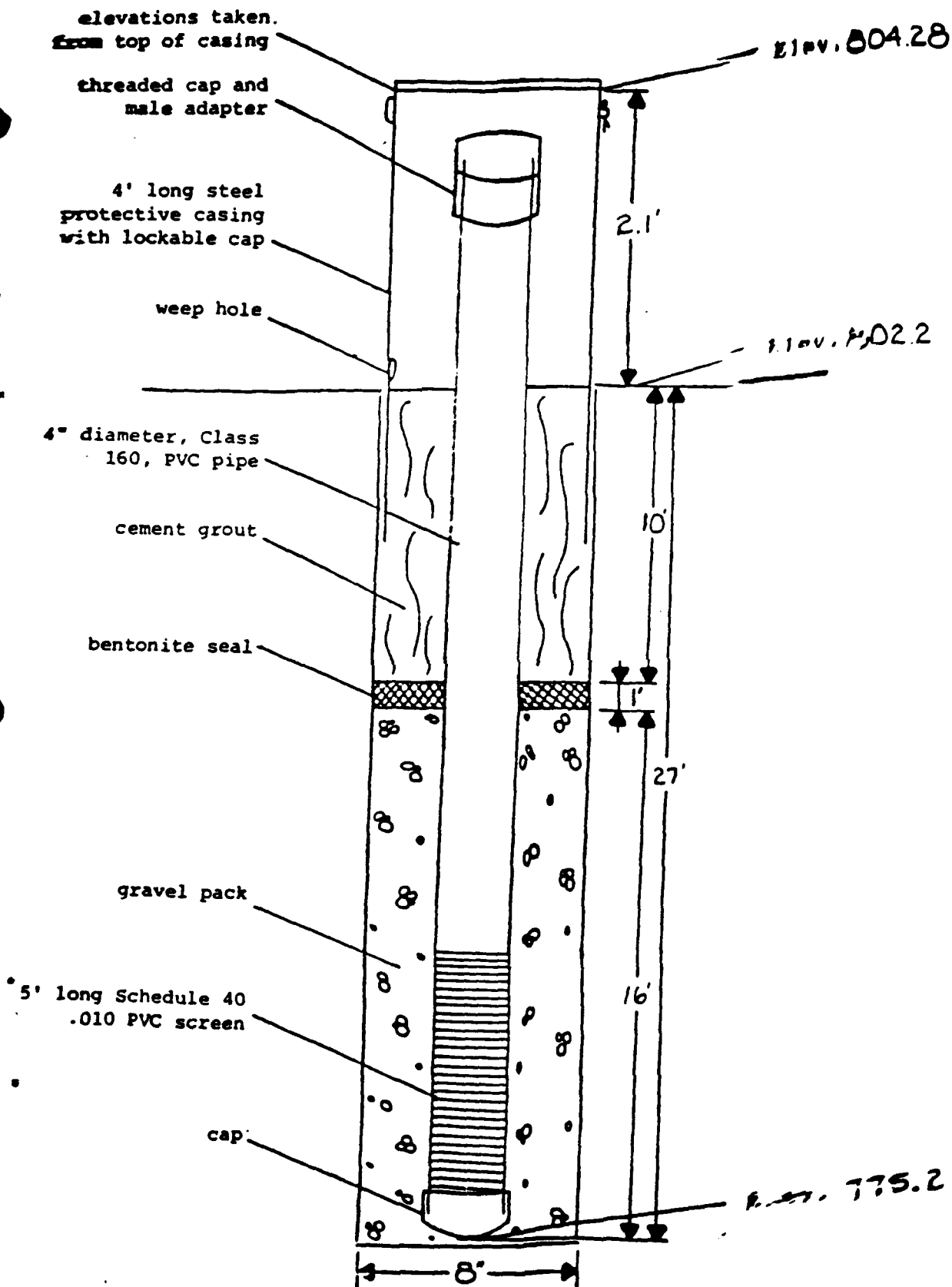
Time

Date _____

(Completer

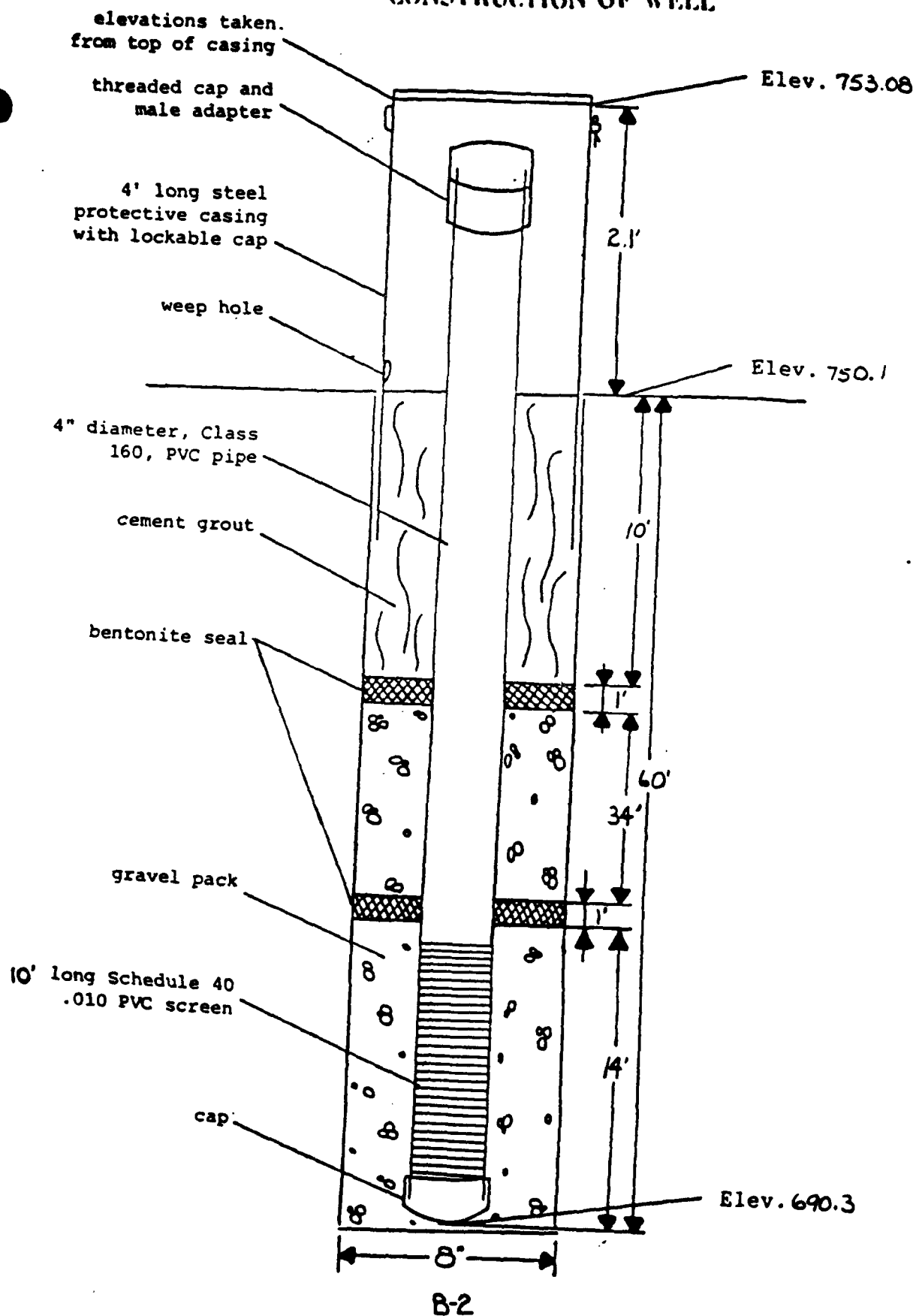
C-296

CONSTRUCTION OF WELL



B-1

CONSTRUCTION OF WELL



TEST BORING LOG

ect Lake City Army Ammunition Plant

Boring No. **B-2**

Sheet 2 of 2

Surface Elevation _____ **Offset** _____

Date Started 2/2/82 Completed 2/3/82

& State Independence, Missouri

Driller T. Butler Rig D-1

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

9KS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

Aged for 1.5 hours

(Completion)

~~10 GPM steady & clear (Total Depth of Well = 60')~~

26.25

11:30

2/17/82

Sydney-Western Company, Inc.

C-300

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. B-2 Sheet 1 of 2

Surface Elevation 751.0 Offset _____

Address _____

Date Started 2/2/82 Completed 2/3/82

City & State Independence, Missouri

Driller T. Butler Rig D-1

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Water
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Air
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSISTENCY SAND DENSITY
FROM	TO		POCKET PENETROMETER	NO OF BLOWS		
0.0	1.0	WB				Top soil
1.0	7.5	WB				Dark brown silty clay, medium to stiff
7.5	12.5	WB				Brown silty clay, medium to soft
12.5	15.0	WB				Gray clay w/trace very fine sand, & weathered shale
15.0	20.0	WB				Shale, medium to soft
20.0	27.0	WB				Same
27.0	30.0	WB				Gray silty clay, medium to stiff
30.0	35.0	WB				Same
35.0	40.0	WB				Same
40.0	43.5	WB				Same
43.5	45.5	WB				Gray silty clay, medium to soft
45.5	50.0	WB				Gray fine sand, trace medium sand
50.0	55.0	WB				Same
55.0	60.0	WB				Same
60.0	63.0	WB				Gray fine sand, trace very fine sand
63.0	69.0	WB				Gray fine sand, trace medium sand

AKS: (Casing, Water Loss, Etc.)

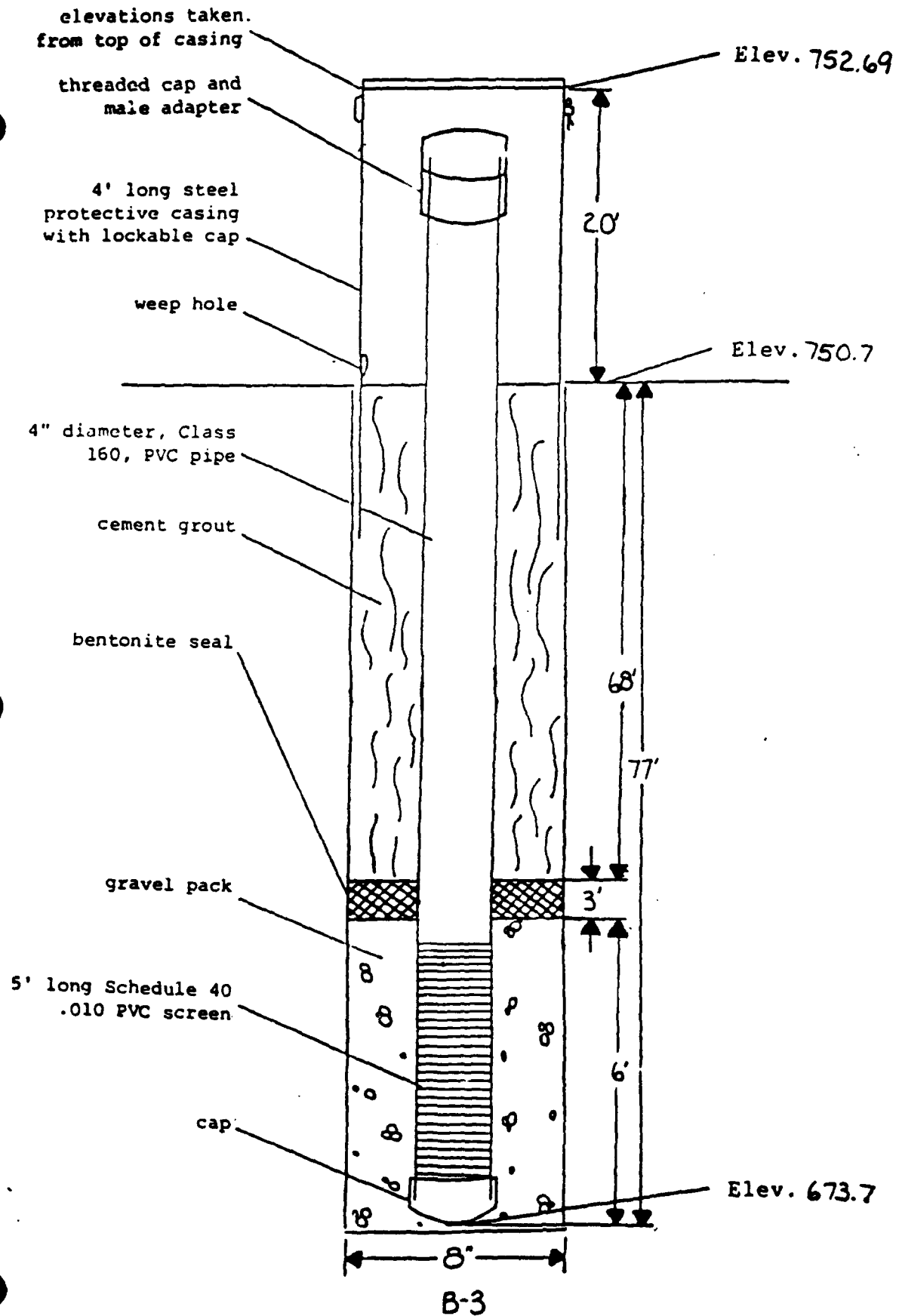
Water Level

Time

Date

(Completion)

CONSTRUCTION OF WELL



TEST BORING LOG

Boring No. B-3 Sheet 2 of 2

Surface Elevation 750.7 Offset

Date Started 2/16/82 Completed 2/18/82

Driller T. Butler Rig D-1

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. - Core Wash
H.A. - Hollow Auger S.S. - Split Spoon C.A. - Core Auger
W.B. - Wash Bore S.T. - Shelby Tube F.B. - Finger Bit

[illegible]

MARKS: (Casing, Water Loss, Etc.)

Time

Date _____

10:00 AM

2/18/82(Comple

TEST BORING LOG

Project Lake City Army Ammunition Plant

Boring No. B-3 Sheet

Surface Elevation 750.7 Offset

Address

Date Started 2/16/82 Completed 2/17

City & State Independence, Missouri

Driller T. Butler Rig D-1

Abbreviations: A.O. - Auger Only R.B. - Rock Bit C.W. -
H.A. - Hollow Auger S.S. - Split Spoon C.A. -
W.B. - Wash Bore S.T. - Shelby Tube F.B. -

DEPTH		METHOD	PENETRATION RECORD		CORE RECOVERY	SAMPLE DESCRIPTION COLOR-MATERIAL-MOISTURE-CLAY CONSIS SAND DENSIT.
FROM	TO		POCKET PENETRO METER	NO OF BLOWS		
0.0	0.5	WB				Topsoil
0.5	8.0	WB				Dark brown silty clay, medium to soft
8.0	13.0	WB				Brown silty clay, soft to medium
13.0	26.5	WB				Gray silty clay, w/trace of weathered & trace fine sand, soft to medium
26.5	28.0	WB				Gray clay, trace of fine sand, medium
28.0	34.0	WB				Gray clay, medium to soft
34.0	42.0	WB				Gray clay, medium to stiff
42.0	45.5	WB				Gray fine sand, trace of medium sand
45.5	50.0	WB				Same
50.0	55.0	WB				Same
55.0	60.0	WB				Same
60.0	65.0	WB				Same
65.0	69.0	WB				Same
69.0	69.5	WB				Limestone
69.5	71.5	WB				Gray shale, medium to hard
71.5	74.5	WB				Light gray limy shale, medium to hard

REMARKS: (Casing, Water Loss, Etc.)

Water Level

Time

Date

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 2/20/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #1 (17A)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		BLACK SOIL (SLIGHTLY SILTY CLAY)	ELEV. 741.6'
		YELLOW SANDY CLAY	STATIC WATER LEVEL: 16.5'
10			PRODUCTION: 438 gpm WITH 6.5' DRAWDOWN
20			
		SAND, MEDIUM TO COARSE ARKOSIC	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 2/20/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #1 (17A)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30			
40			
50			
60		SAND, MEDIUM TO COARSE, ARKOSIC SOME LIGNITE	

DRILLING LOG

PROJECT WATER SUPPLY WELLS DATE 2/20/41
 LOCATION _____ DRILLERS _____
 DRILL RIG _____ BORE HOLE 1 (17A)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60			
	00000	CORSE SAND AND GRAVEL; FEW BOULDERS	
	00000		
70	00000		
	00000		
	00000		
80	00000		
	00000		
TD	85.0	?	25' OF 18" STAINLESS STEEL SHUTTER SCREEN 6" PLUG IN BOTTOM: TOP OF PLUG = 84.5' TD Top of Pleasanton St.?

DRILLING LOG

PROJECT WATER SUPPLY WELL

DATE 4/23/41

LOCATION _____

DRILLERS LAYNE-WESTERN

DRILL RIG _____

BORE HOLE #2 (178)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		BLACK SOIL (SLIGHTLY SILTY CLAY)	ELEV. 739.1' STATIC WATER LEVEL: 11.0' PRODUCTION: 330 gpm 8' DRAWDOWN
		YELLOW CLAY	
10			
		FINE SAND	
20		BLUE SANDY CLAY	
		FINE SAND	
30			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 4/23/41
 LOCATION _____ DRILLERS LAYNE - WESTERN
 DRILL RIG _____ BORE HOLE #2 (17B)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30		FINE TO MEDIUM SAND	
40			
50	000000	COARSE SAND AND GRAVEL	
60	000000		

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 4/23/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #2 (178)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60			
70			
80			
TD 80.8		<p>Top of Pleasanton sh</p>	<p>25' OF 18" STAINLESS STEEL SHUTTER SCREEN</p> <p>12" PLUG IN BOTTOM: TOP OF PLUG: 79.9'</p>

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 4/30/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #3 (17C)

Page 1 of 3

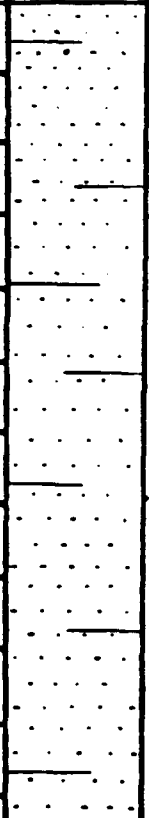
FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		BLACK SOIL (SLIGHTLY SILTY CLAY)	ELEV. 744.7 STATIC WATER LEVEL: 17.4' PRODUCTION: 421 gpm 6' drawdown
		BROWN CLAY	
10		SANDY CLAY	
20		FINE SAND	
		SOFT YELLOW CLAY	
32		FINE SAND	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 4/30/41
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #3 (17C)

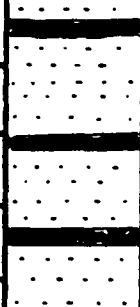
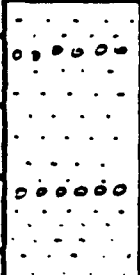
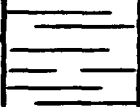
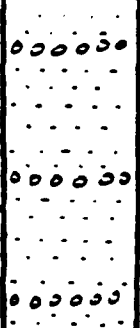
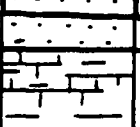
Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30 40 50			
		BLUE CLAY COARSE SAND & LIGNITE	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 4/30/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #3 (17C)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60			
70		COARSE SAND & GRAVEL	
80		SOFT BLUE CLAY	25' OF 18" STAINLESS STEEL SHUTTER SCREEN
90		COARSE SAND & GRAVEL	12" PLUG IN BOTTOM TOP OF PLUG: 89'
TD 90.3		PLEASANTON SH YELLOW SHALE & LIMESTONE	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/17/41
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #4 (170)

Page 1 of 4

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		SOIL (SLIGHTLY SILTY CLAY)	ELEV. 745.3' STATIC WATER LEVEL: 16.3' PRODUCTION: 368 gpm 8' DRAWDOWN
		SANDY CLAY	
10		DRY SAND	
		FINE SAND	
20			
		BLUE CLAY	
32			

DRILLING LOG

PROJECT WATER SUPPLY WELL

DATE 5/17/41

LOCATION _____

DRILLERS LAYNE-WESTERN

DRILL RIG _____

BORE HOLE #4 (170)

Page 2 of 4

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30			
		FINE, SILTY SAND	
40			
		COARSE TO MEDIUM SAND	
		FINE SAND	
50			
		COARSE SAND & GRAVEL	
60			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/17/41
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #4 (17D)

Page 3 of 4

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60	000000		
	000000		
		FINE SAND	
		COARSE SAND	
70			
80			
		FINE SAND	
90			

DRILLING LOG

PROJECT WATER SUPPLY Well DATE 5/17/41
LOCATION _____ DRILLERS LAYNE - WESTERN

DRILL RIG _____ BORE HOLE #4 (170)

Page 4 of 4

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
90			
	000000	COARSE SAND & GRAVEL	25' OF 18" STAINLESS STEEL SHUTTER SCREEN
	000000		10" PLUG IN BOTTOM
	000000		TOP OF PLUG: 97.3'
TD 98.5		TOP OF PLEASANTON SH	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/23/41
 LOCATION _____ DRILLERS LATHE-WESTERN

 DRILL RIG _____ BORE HOLE #5 (17E)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		SOIL	ELEV. 741.6'
		BLUE CLAY	STATIC WATER LEVEL: 12.9'
			PRODUCTION: 427 gpm 6' DRAWDOWN
10			
20			
30		FINE SAND	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/23/41
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #5 (17E)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
35			
		CLAY	
		FINE SAND	
40			
50			
60			

DRILLING LOG

PROJECT WATER SUPPLY WELL

DATE 5/23/41

LOCATION. _____

DRILLERS LAZYNE-W. STERN

DRILL RIG _____

BORE HOLE #5(1-5)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60			
		COARSE SAND	
70			
80			
	o o o o o	COARSE SAND, GRAVEL,	25' OF 18" STEEL WIRELESS
		BOULDERS	STEEL SHUT-TOFF SCREEN
	o o o o o		12" PLUG IN AT BOTTOM
	o o o o o		TOP OF PLUG - 8
T.D.		P	
87.8'		Top of PIER ANTON SH	
(?)			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/6/41
 LOCATION _____ DRILLERS LAYNE - WESTERN
 DRILL RIG _____ BORE HOLE #7 (176)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		BLACK SOIL (SLIGHTLY SILTY CLAY)	ELEV. 737.0'
		BROWN CLAY	STATIC WATER LEVEL: 9.0'
10			PRODUCTION: 348 gpm 10.5' DRAWDOWN
20		FINE SAND	
30			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/6/41
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #7(176)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
35			
40			
50			
60			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/6/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #7 (176)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60			
		COARSE SAND AND GRAVEL	
	000000		
70	000000		
	0000000		
TD	79.3'		

25' OF 18" STAINLESS
 STEEL SHUTTER SCREEN
 14" PLUG IN BOTTOM
 TOP OF AUG: 78.2'

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 10/15/42
 LOCATION _____ DRILLERS _____
 DRILL RIG _____ BORE HOLE #5 (17M)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		SOIL (SLIGHTLY SANDY CLAY)	ELEV. 741.5' STATIC WATER LEVEL: 16.0' PRODUCTION: 350 GPM 22' DRAWDOWN
		HARD BLUE CLAY	
10			
20			
		SANDY CLAY	
30			
		VERY FINE SAND, STREAKS OF CLAY	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 10/15/42
 LOCATION _____ DRILLERS _____
 DRILL RIG _____ BORE HOLE #B (17M)

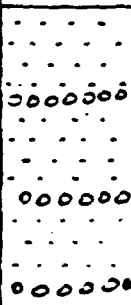
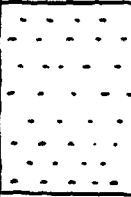
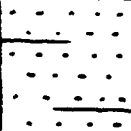
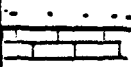
Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30			
40		FINE SAND	
50		MEDIUM TO FINE SAND	
60		MEDIUM TO COARSE SAND	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 10/15/42
 LOCATION _____ DRILLERS _____
 DRILL RIG _____ BORE HOLE #8 (17M)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60			
70		SAND WITH SOME GRAVEL	
80		COARSE SAND	25' OF 18" STAINLESS STEEL SHUTTER SCREEN 10' PLUG IN BOTTOM TOP OF PLUG: 85.5'
		VERY FINE SAND	
TD 86.5		TOP OF PLEASANTON SH	

DRILLING LOG

PROJECT WATER SUPPLY WELL

DATE 10/30/42

LOCATION _____

DRILLERS LAYNE - WESTERN

DRILL RIG _____

BORE HOLE #10 (17K)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		(Slightly sandy clay)	ELEV. 740.0' STATIC WATER LEVEL: 20.0' PRODUCTION: 350 gpm 20' DRAWDOWN
		BLACK CLAY	
10		SANDY CLAY	
20		FINE SAND	
30		FINE TO MEDIUM SAND	

DRILLING LOG

PROJECT WATER SUPPLY Well

DATE 10/30/42

LOCATION _____

DRILLERS LAYNE - WESTERN

DRILL RIG _____

BORE HOLE # 10 (17K)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30			
40			
	OOO OOOO	COARSE SAND WITH SOME GRAVEL	
50		FINE TO MEDIUM COARSE SAND	
60			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 10/30/42
 LOCATION _____ DRILLERS LAINE-WESTERN
 DRILL RIG _____ BORE HOLE #10 (171C)

Page 5 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60		FINE SAND	
70		COARSE SAND, GRAVEL, FEW SMALL BOULDERS	
80			25' OF 18" STAINLESS STEEL SHUTTER SCREEN 10" PLUG IN BOTTOM TOP OF PLUG: 86'
TD 87'		TOP OF PLEASANTON SH	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/11/41
LOCATION _____ DRILLERS LAYNE-WESTERN

DRILL RIG _____ BORE HOLE #6 (17F)

Page / of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
		BLACK SOIL (SLIGHTLY SILTY CLAY)	ELEV. 734.6'
		GRAY CLAY	STATIC WATER LEVEL: 9.0'
10			PRODUCTION: 348 gpm 18' DRAWDOWN
		SOFT BLUE CLAY	
20		FINE SAND	
30			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/11/41
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #6 (17F)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30			
40		MEDIUM TO COARSE SAND	
50		SOFT BLUE CLAY	
		FINE BLUE SAND	
		COARSE SAND	
60		SOFT BLUE CLAY	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 5/11/41
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #6 (17F)

Page 3 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60		FINE SAND	25' OF 18" STAINLESS STEEL SHUTTER SCREEN 10" PLUG IN BOTTOM TOP OF PLUG: 82.2'
		COARSE SAND	
70			
80	oooooo oooooo	COARSE SAND, GRAVEL, BOULDERS	
TD 83.5	HP 	TOP OF PLEASANTON SH	

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 10/18/42
 LOCATION _____ DRILLERS LAYNE-WESTERN

 DRILL RIG _____ BORE HOLE #9 (17J)

Page 1 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
10		BLACK CLAY	ELEV. 744.0' STATIC WATER LEVEL: 16.0' PRODUCTION: 350 gpm 18' DRAWDOWN
20		BROWN CLAY	
30			

DRILLING LOG

PROJECT WATER SUPPLY WELL DATE 10/13/42
 LOCATION _____ DRILLERS LAYNE-WESTERN
 DRILL RIG _____ BORE HOLE #9 (17J)

Page 2 of 3

FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
30			
		FINE SAND WITH STREAKS OF CLAY	
40			
		FINE SAND	
50			
60	ooooo	COARSE TO MEDIUM SAND GRAVEL & LIGNITE	

DRILLING LOG

PROJECT WATER SUPPLY WELL

DATE 12/18/12

LOCATION _____

DRILLERS LAYNE WESTERN

DRILL RIG _____

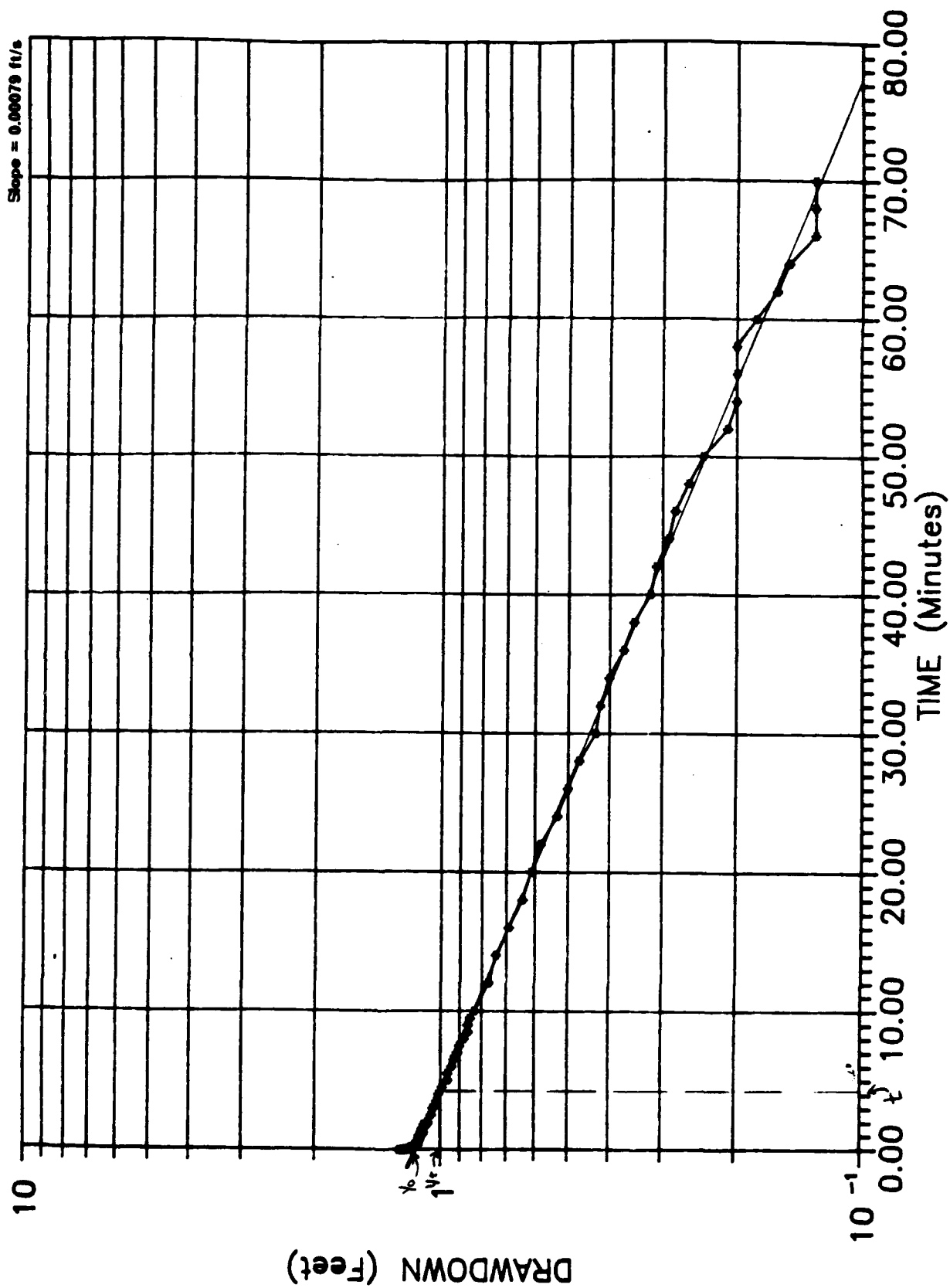
BORE HOLE #9 (17J)

Page 3 of 3

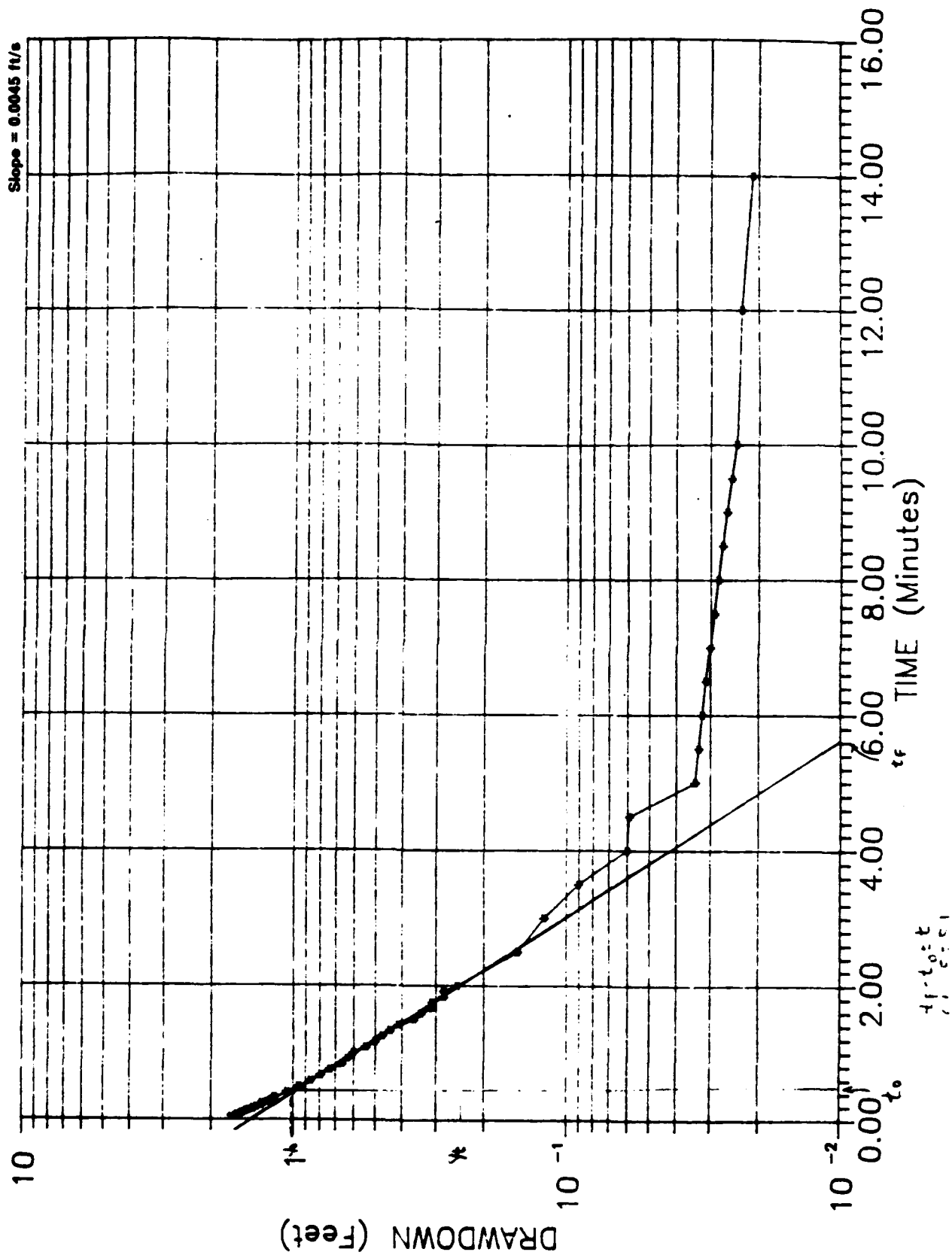
FEET DEPTH	SAMPLE	DESCRIPTION	REMARKS
60		
		
	0000003		
		
		
70		
		
		
	0000000		
		
80		
		
		
TD 84.0	TOP OF PLEASANTON SH	25' OF 18" STAINLESS STEEL SHUTTER SCREEN 10" PLUG IN BOTTOM TOP OF PLUG: 83.2'

APPENDIX D
GEOTECHNICAL DATA

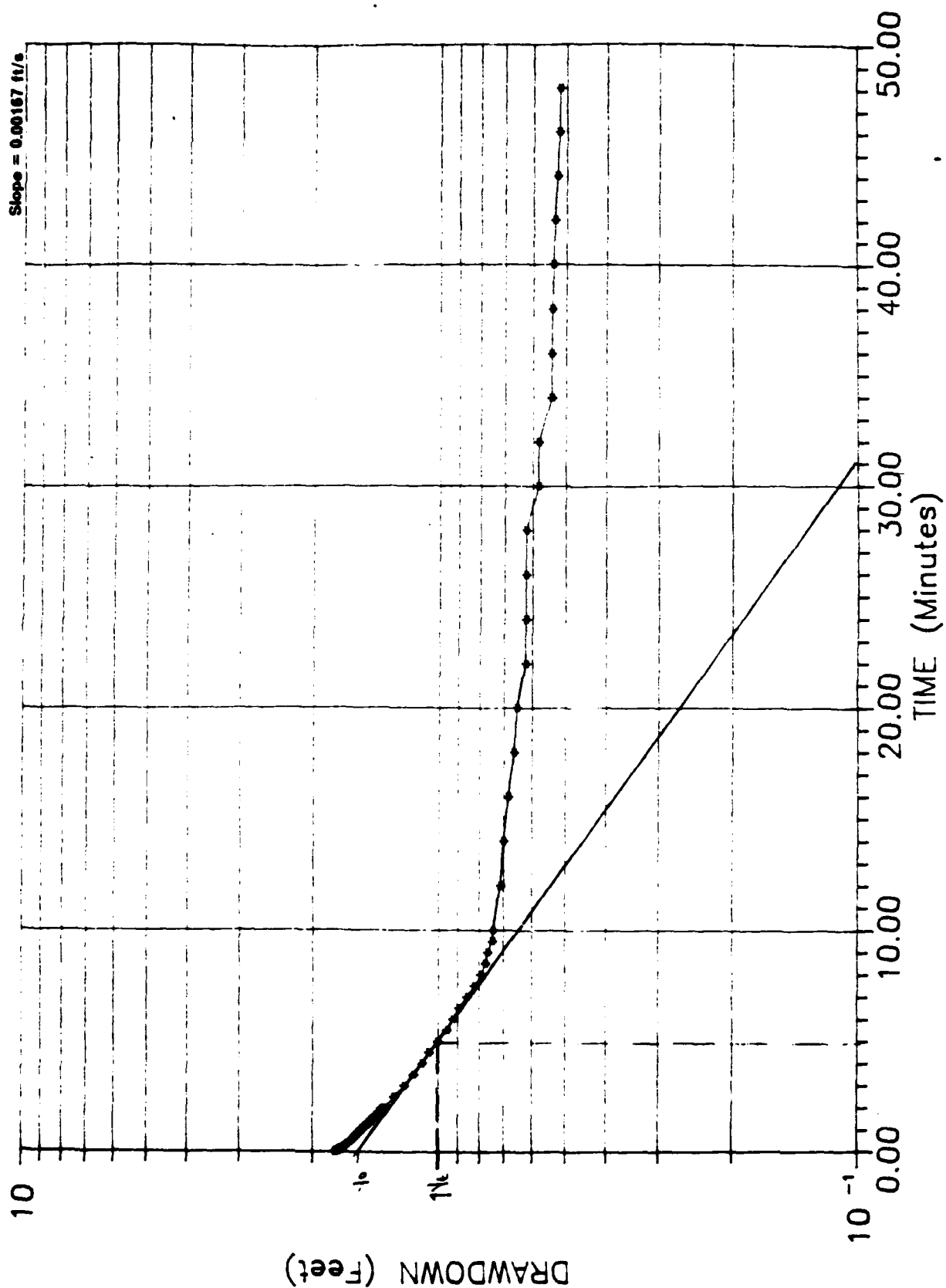
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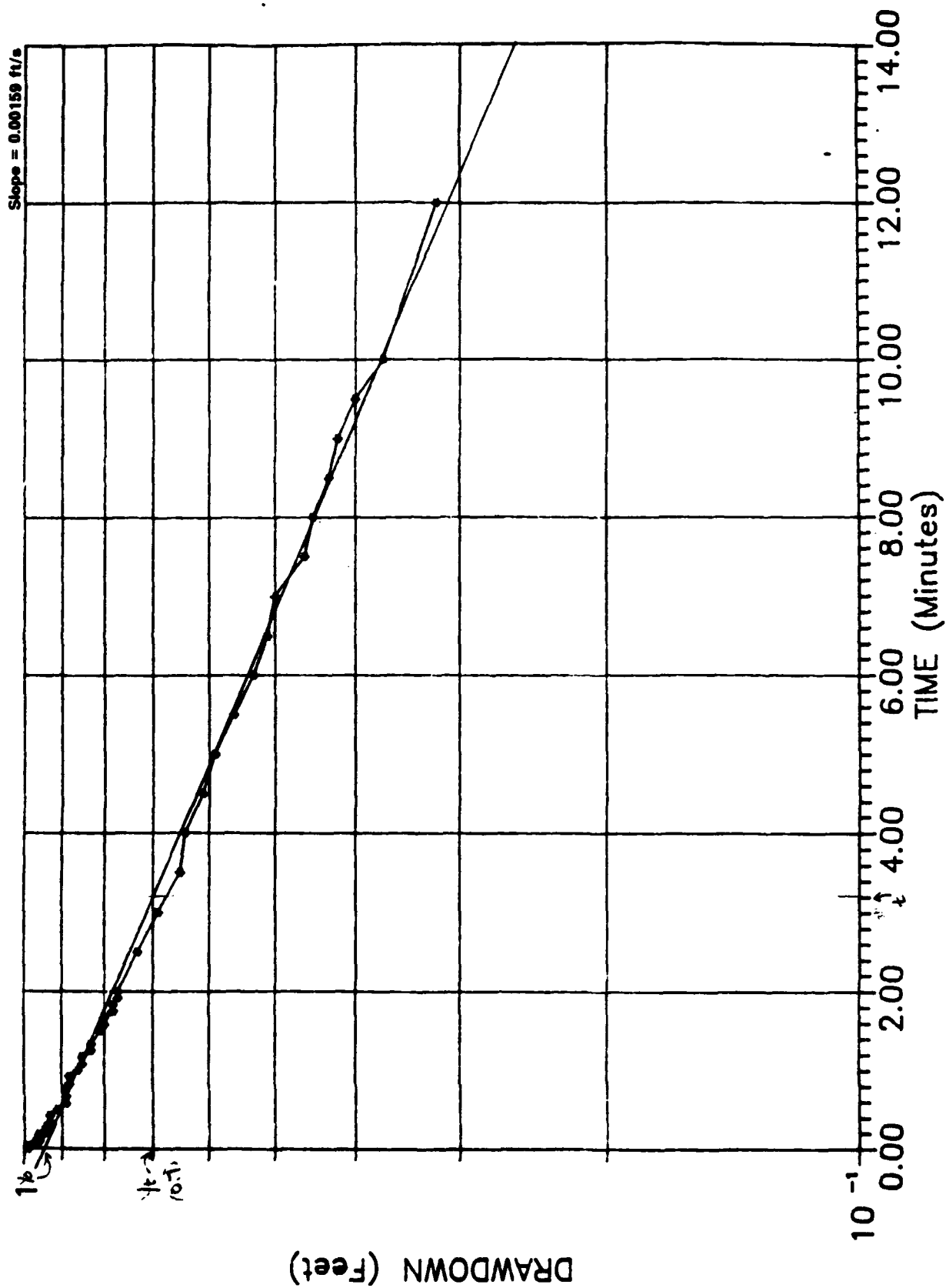
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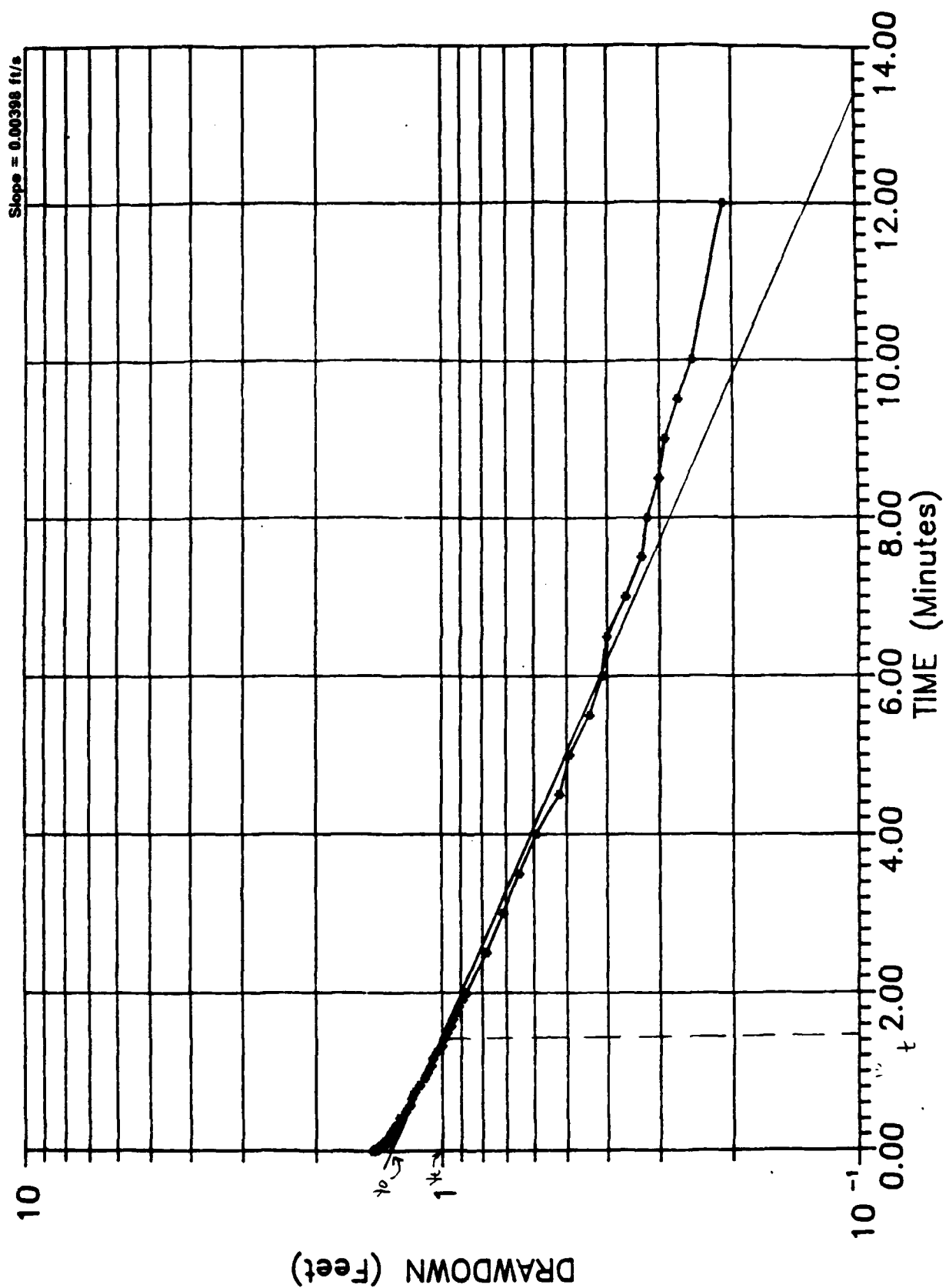
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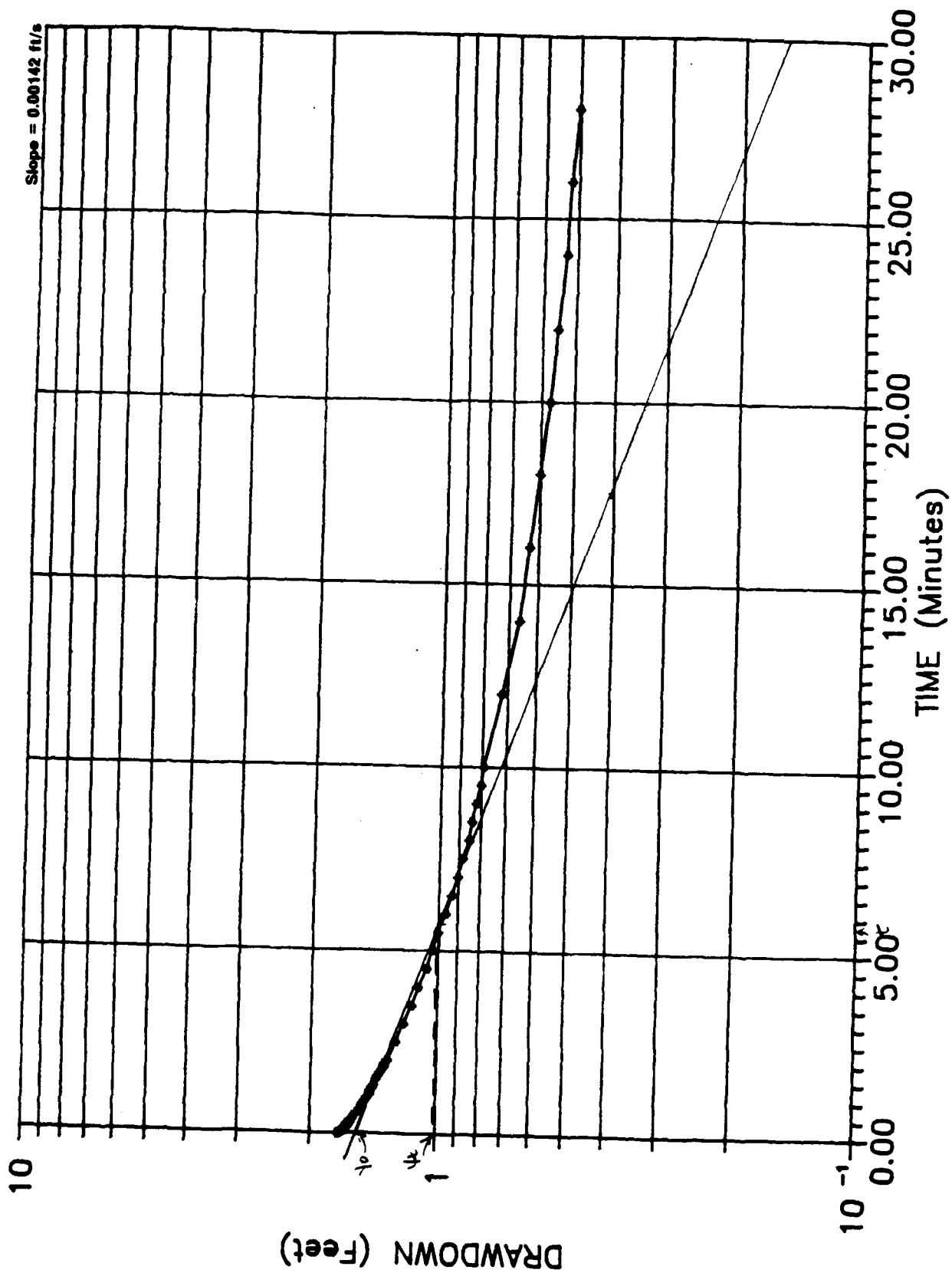
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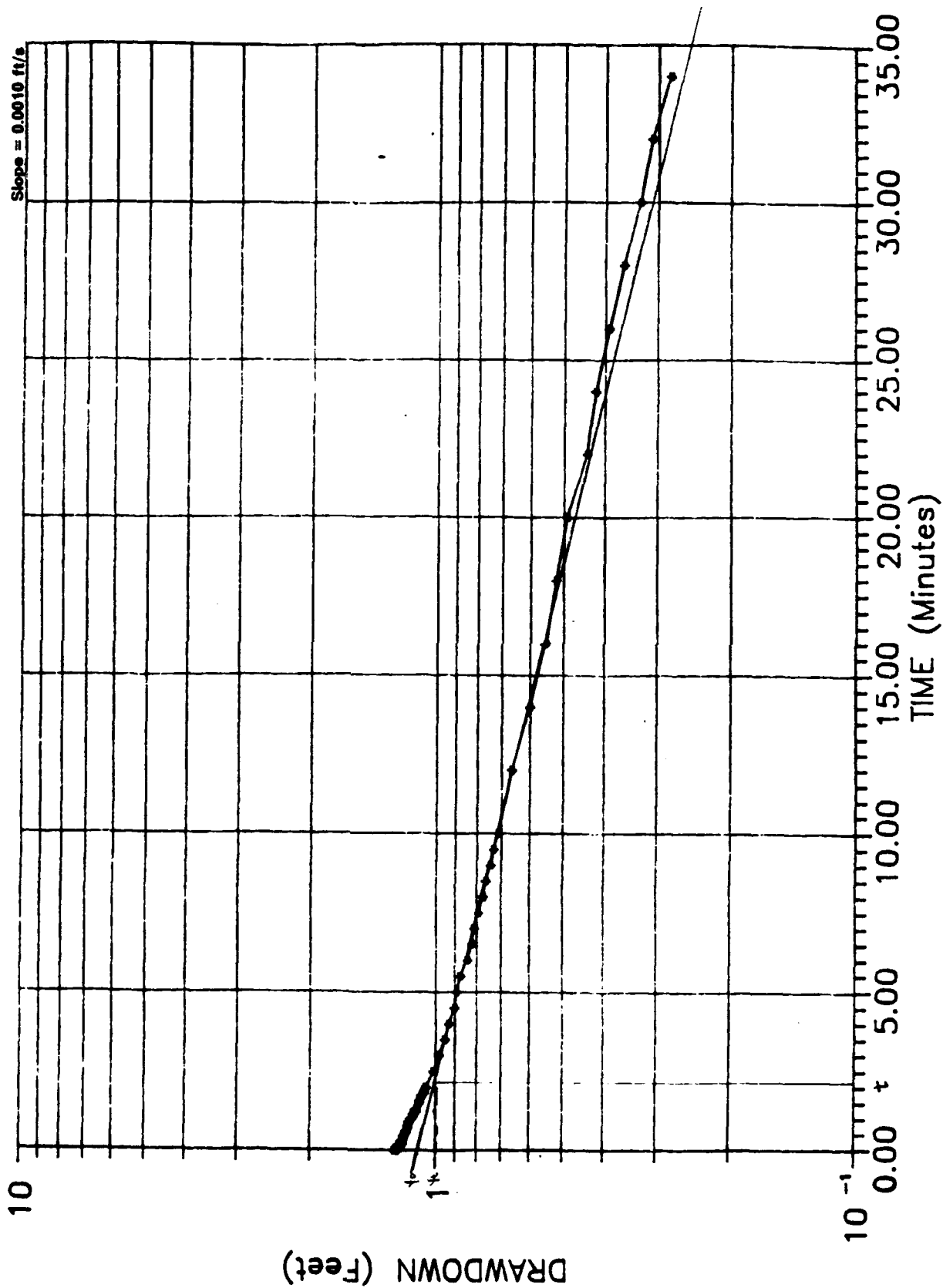
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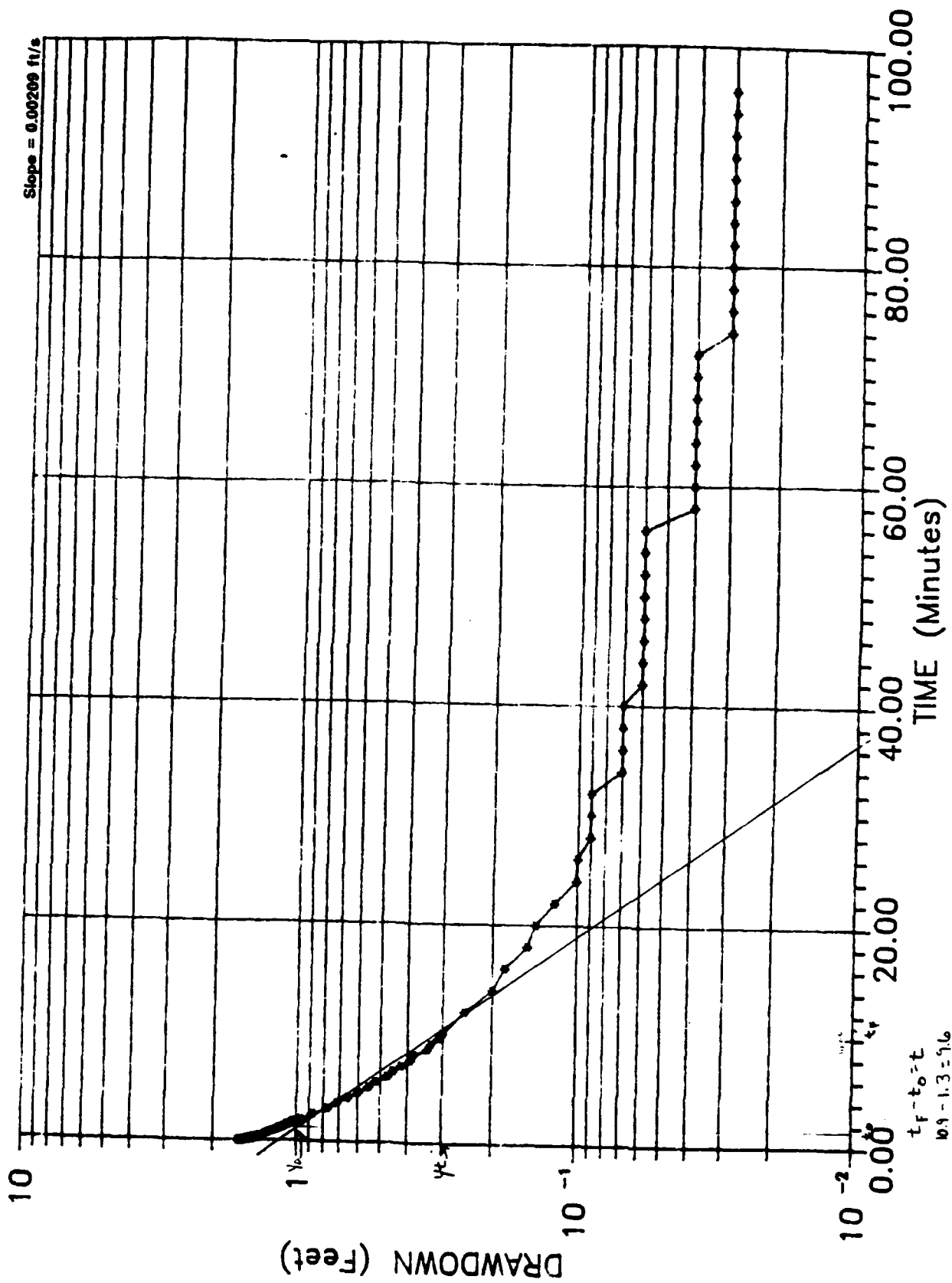
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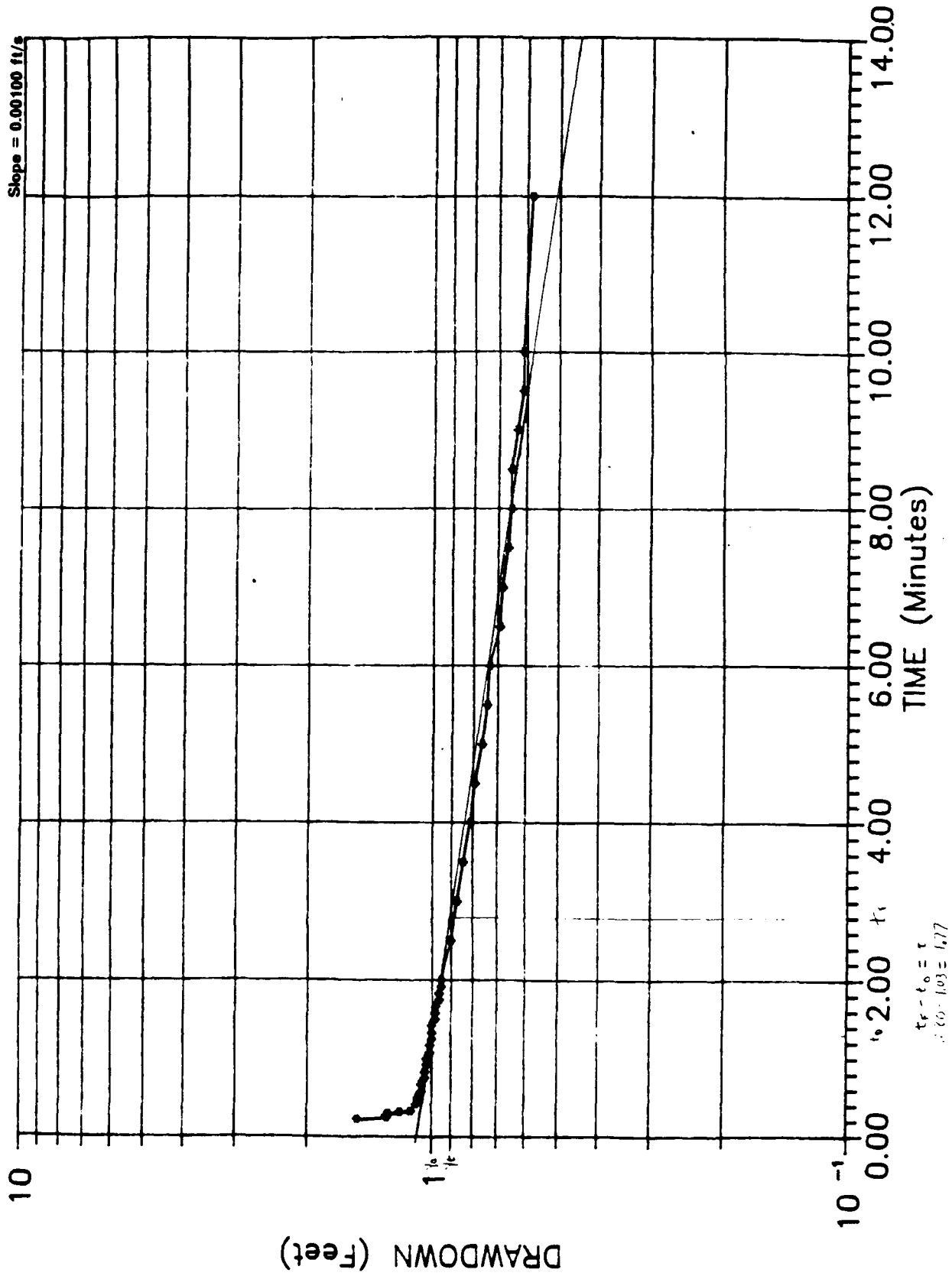
S6-1



S7-8



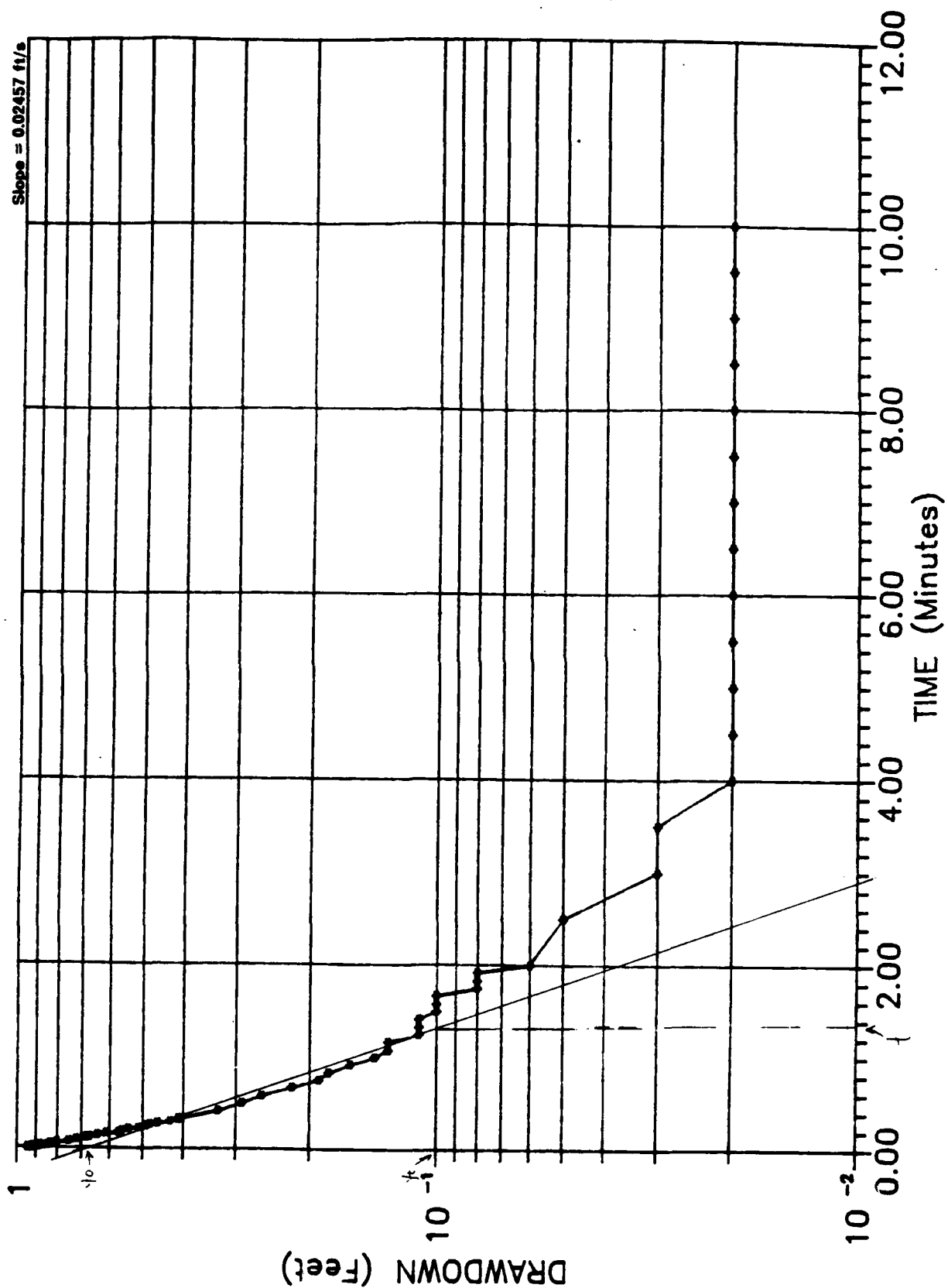
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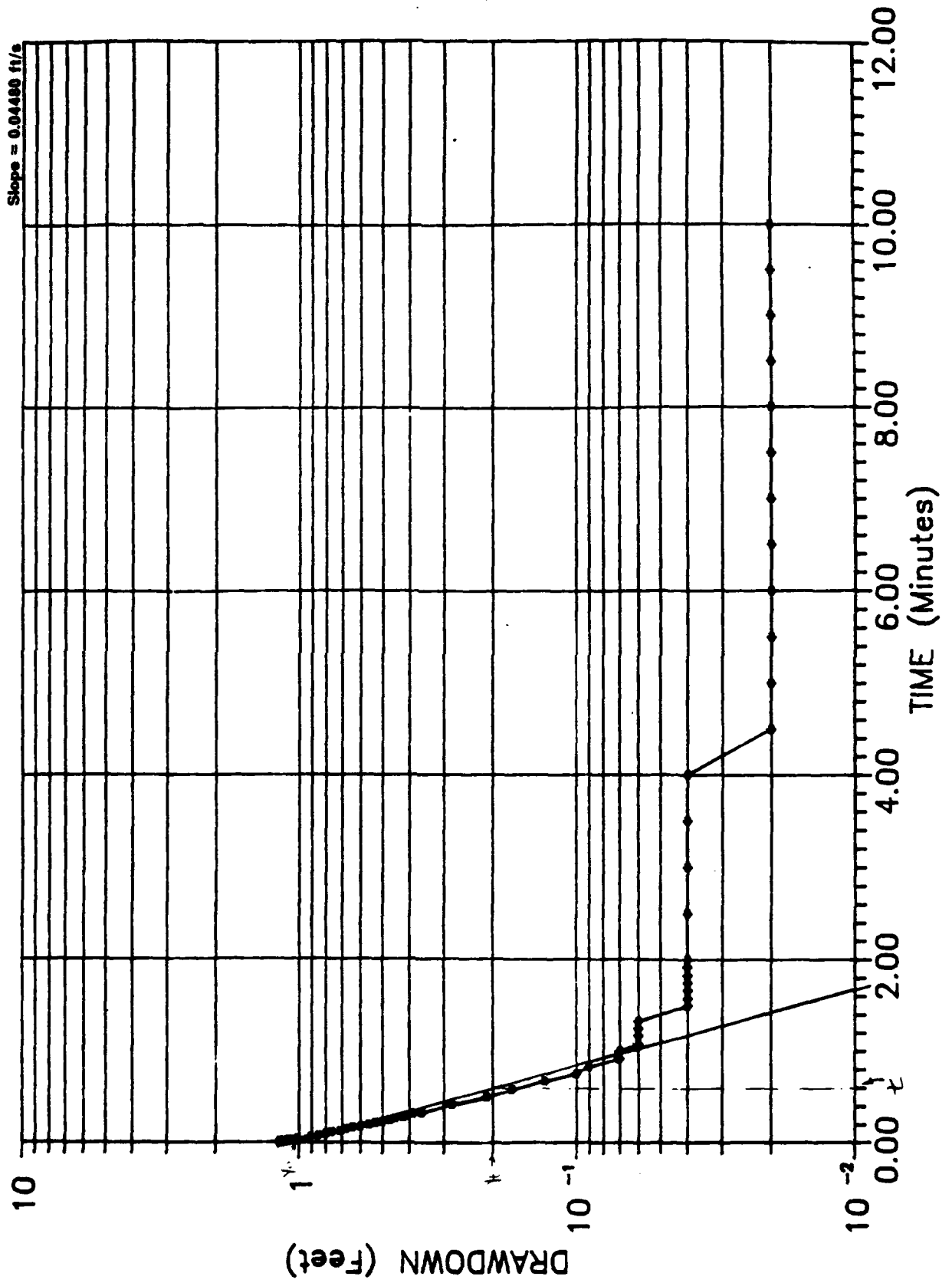
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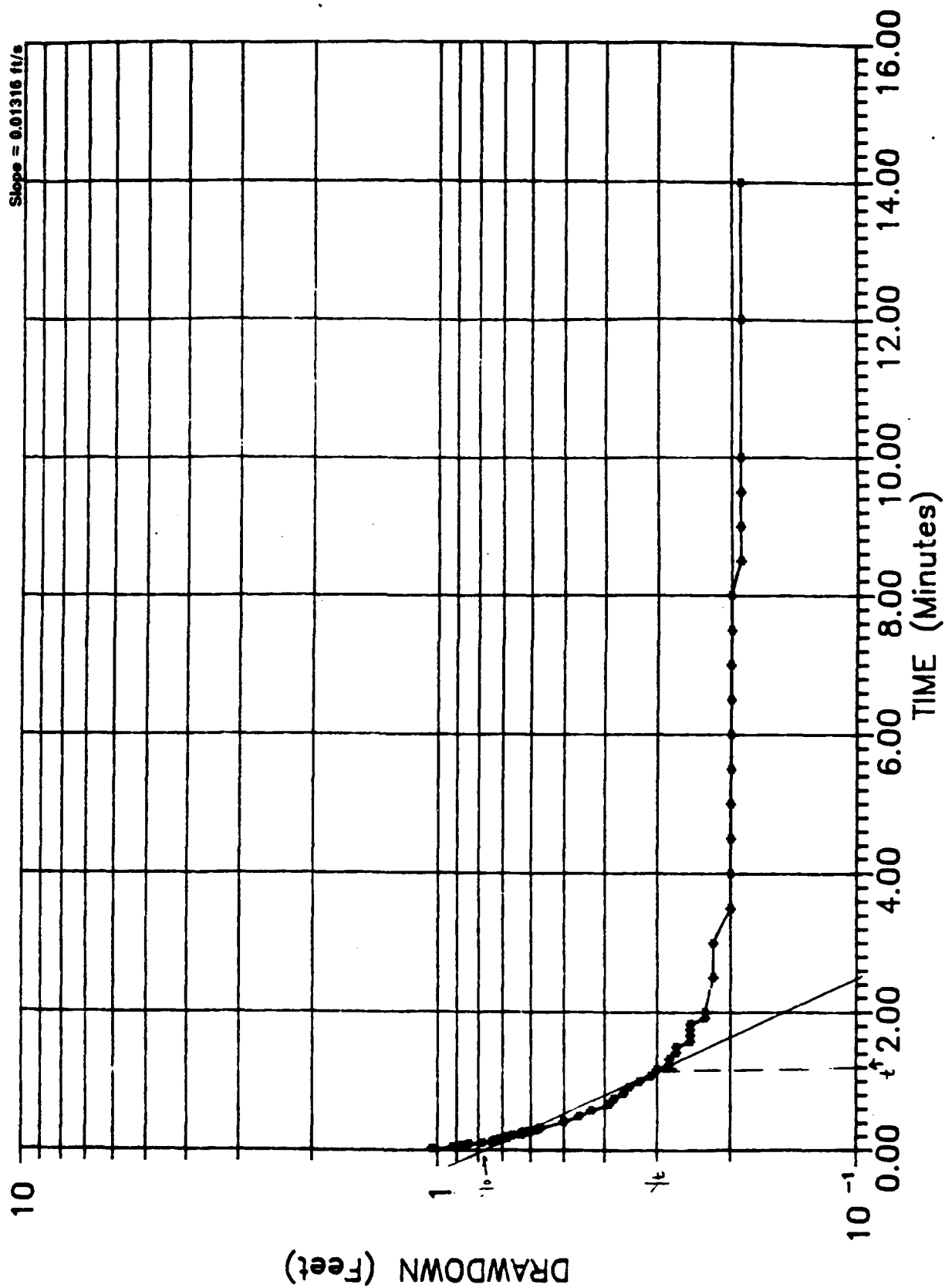
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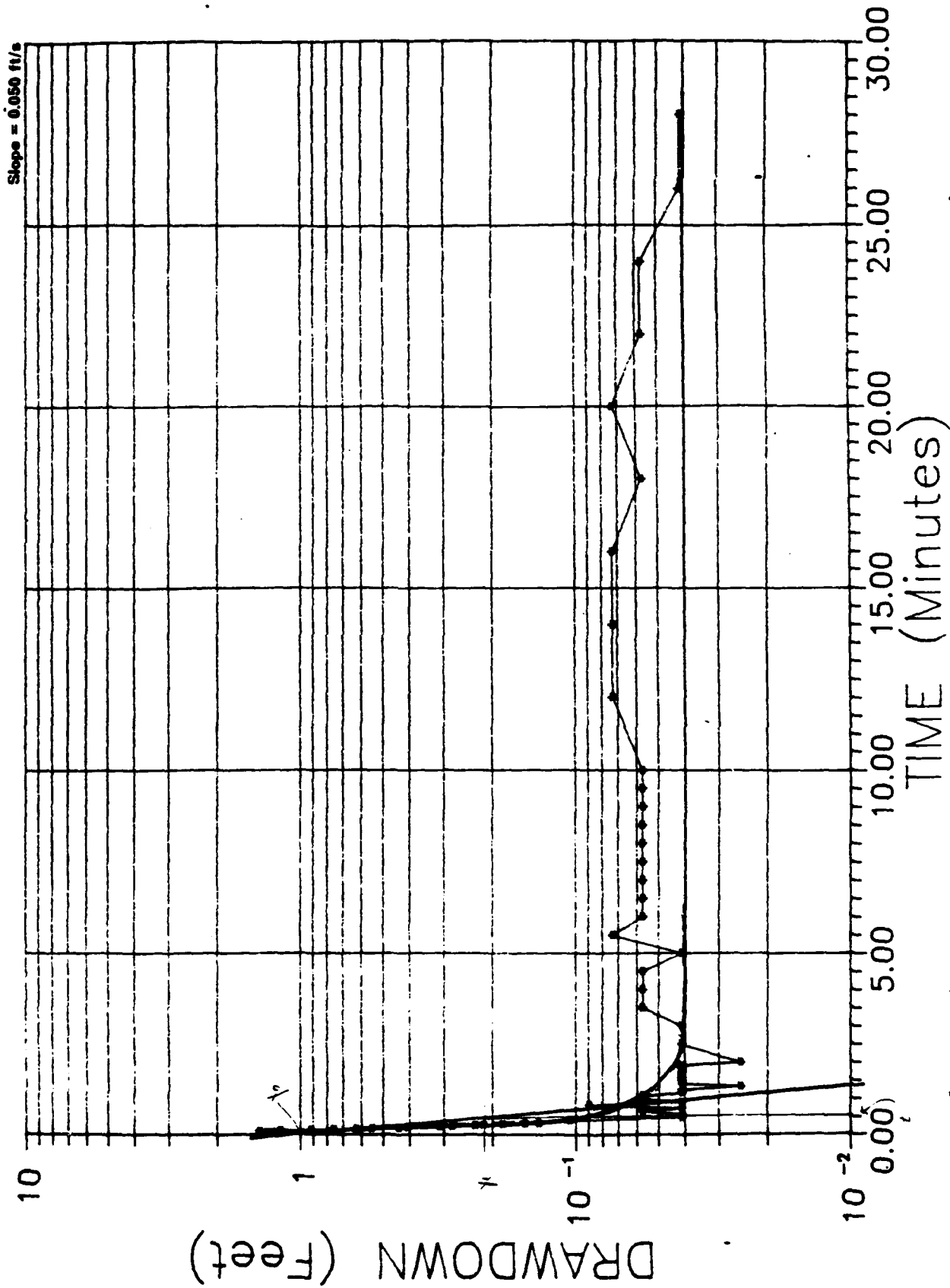
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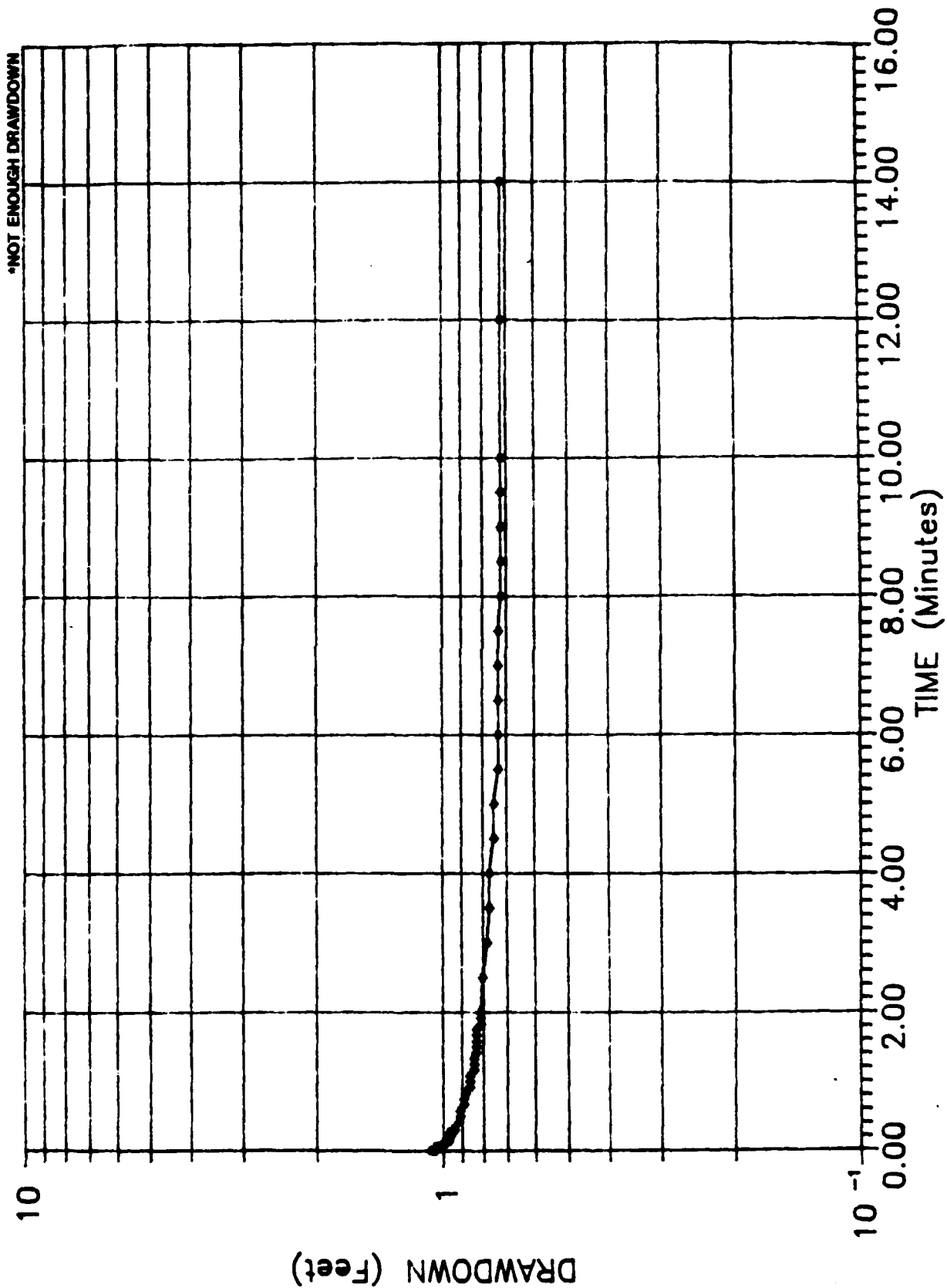
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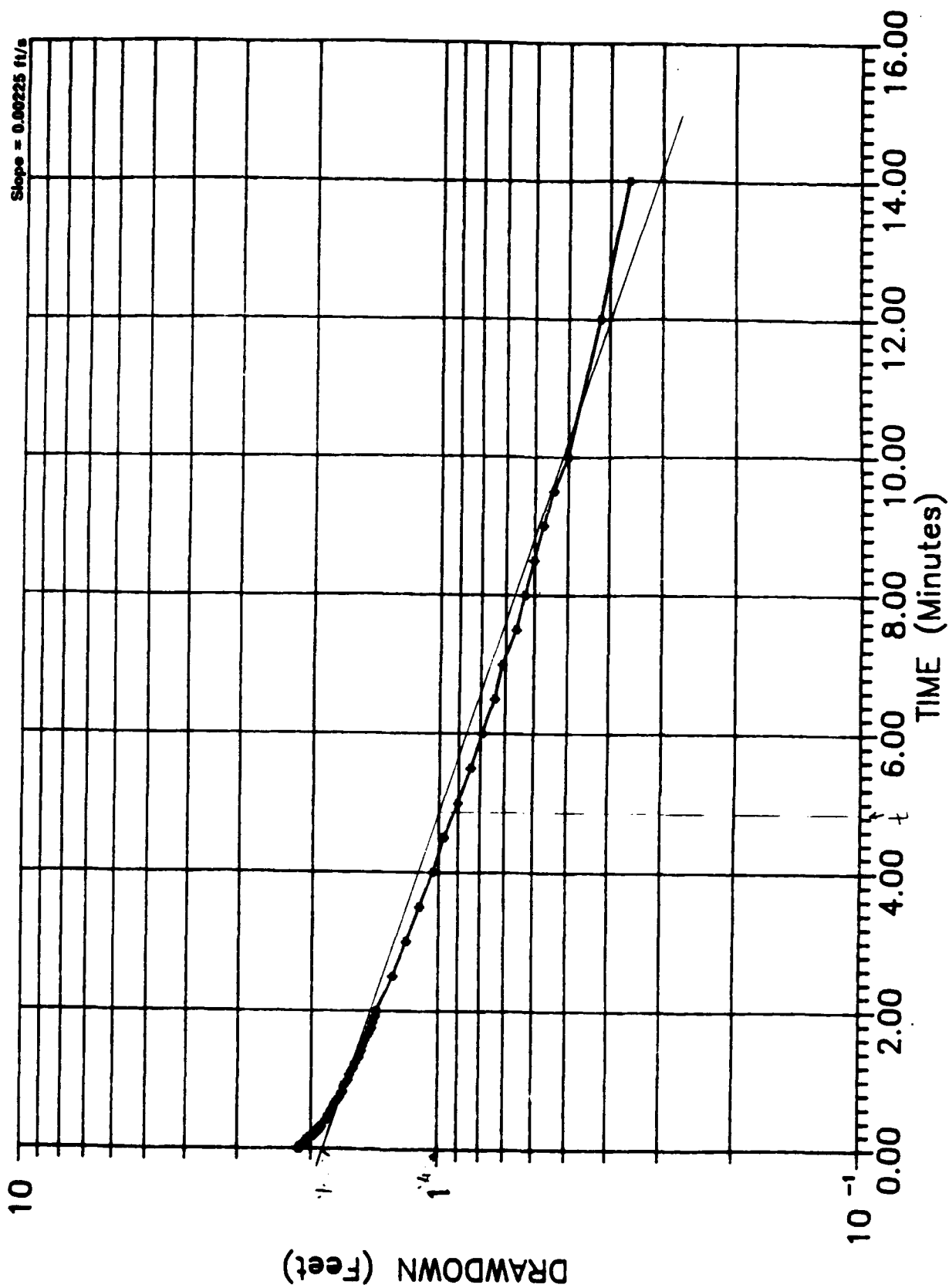
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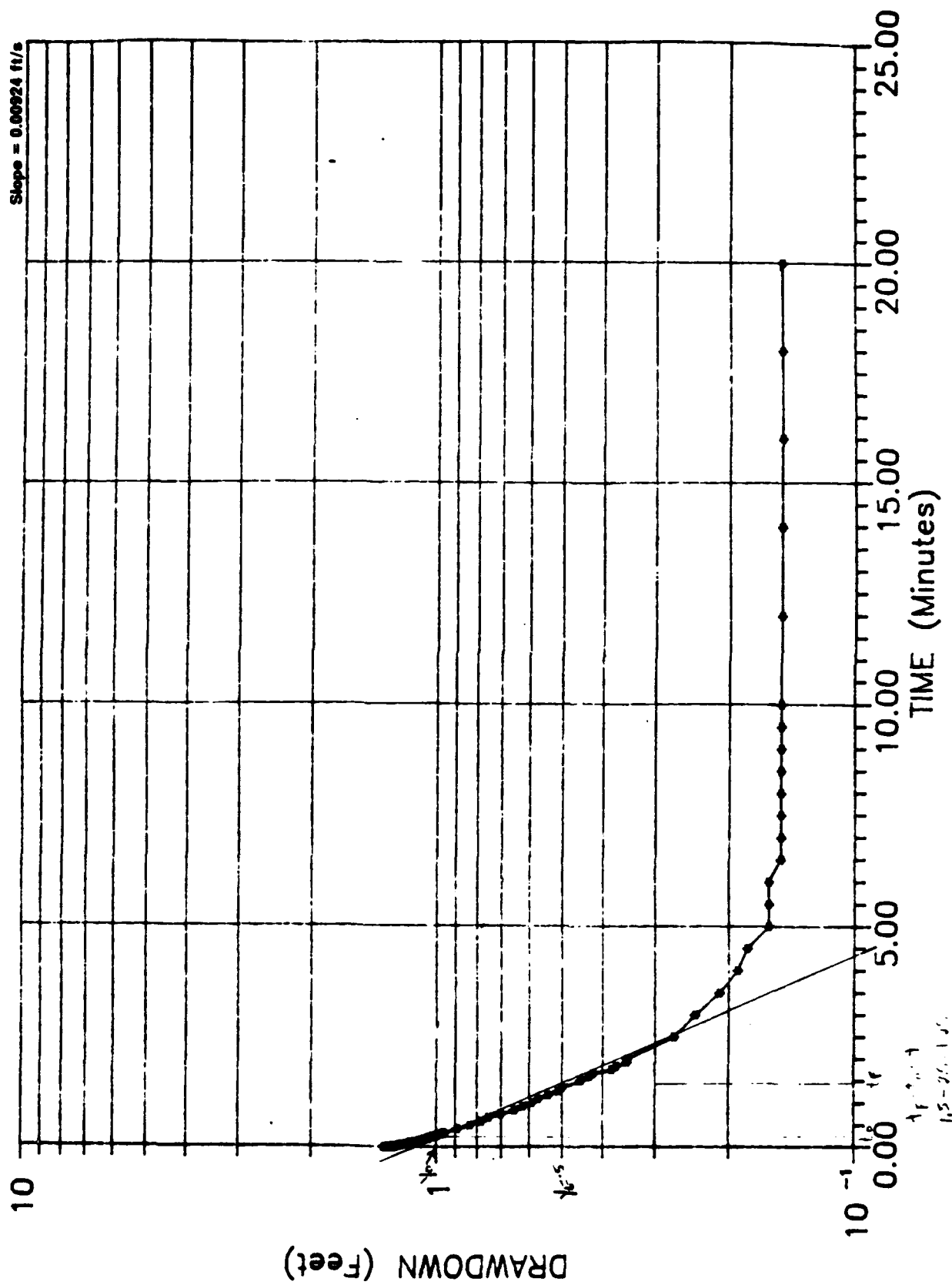
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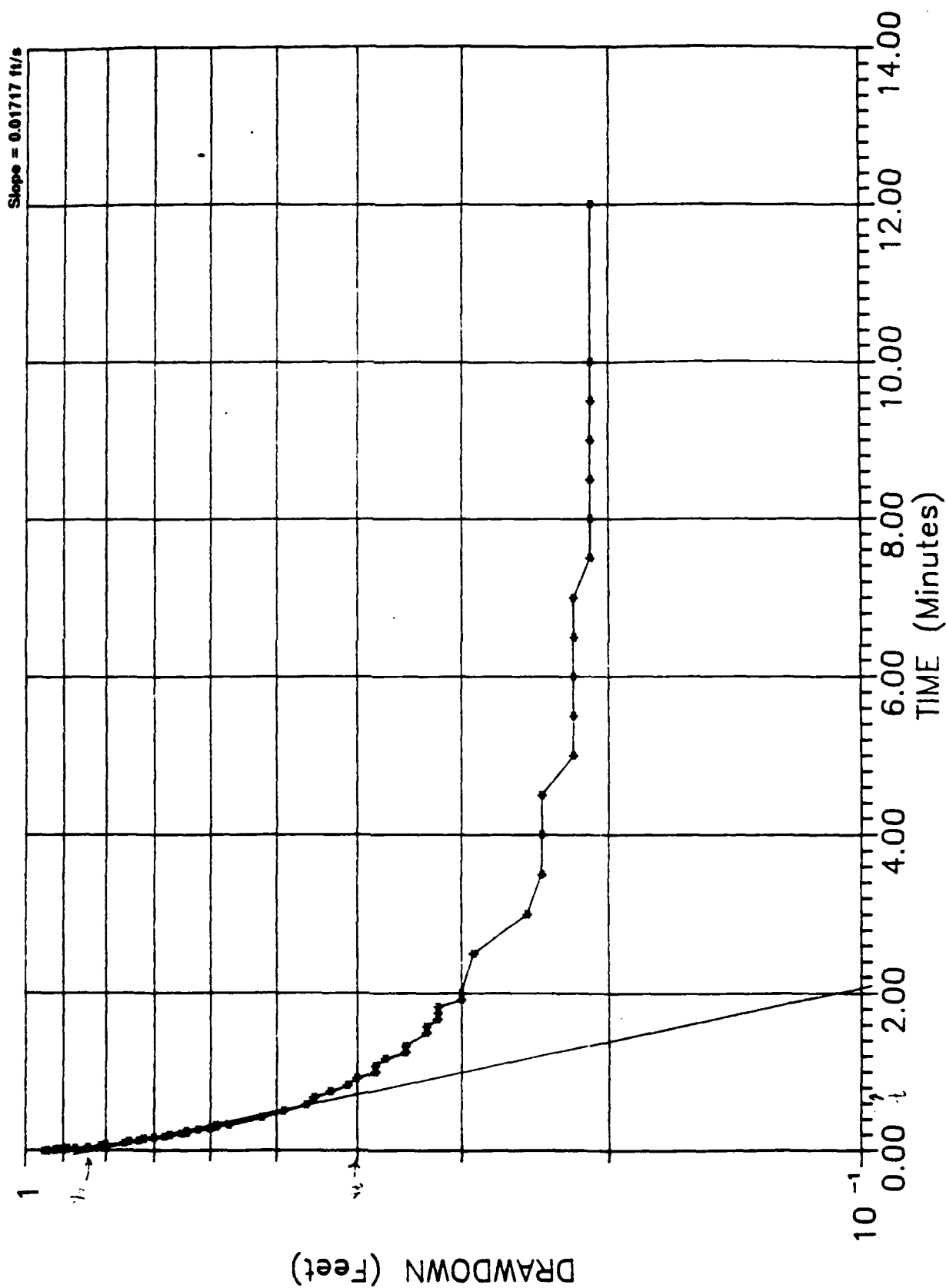
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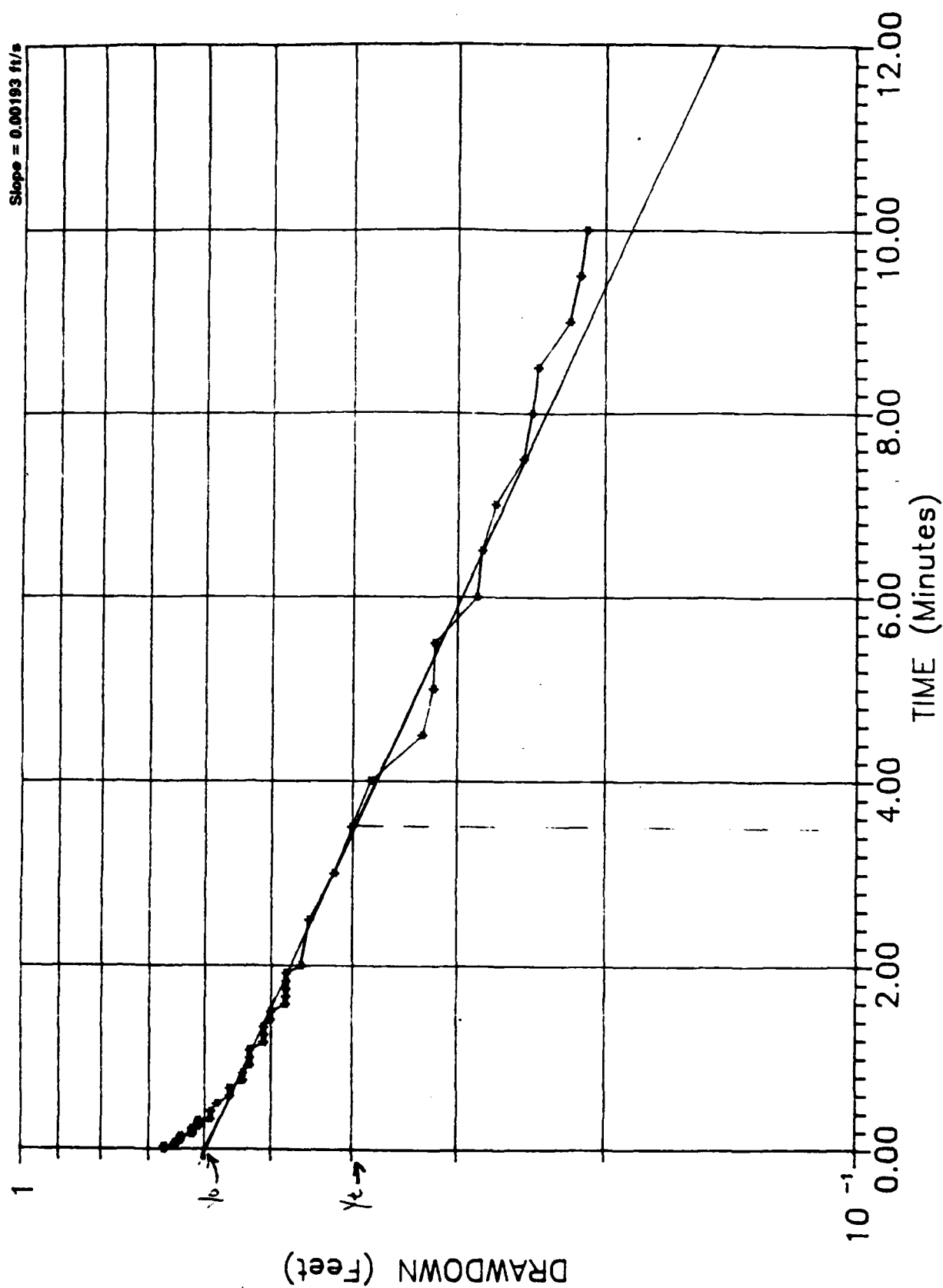
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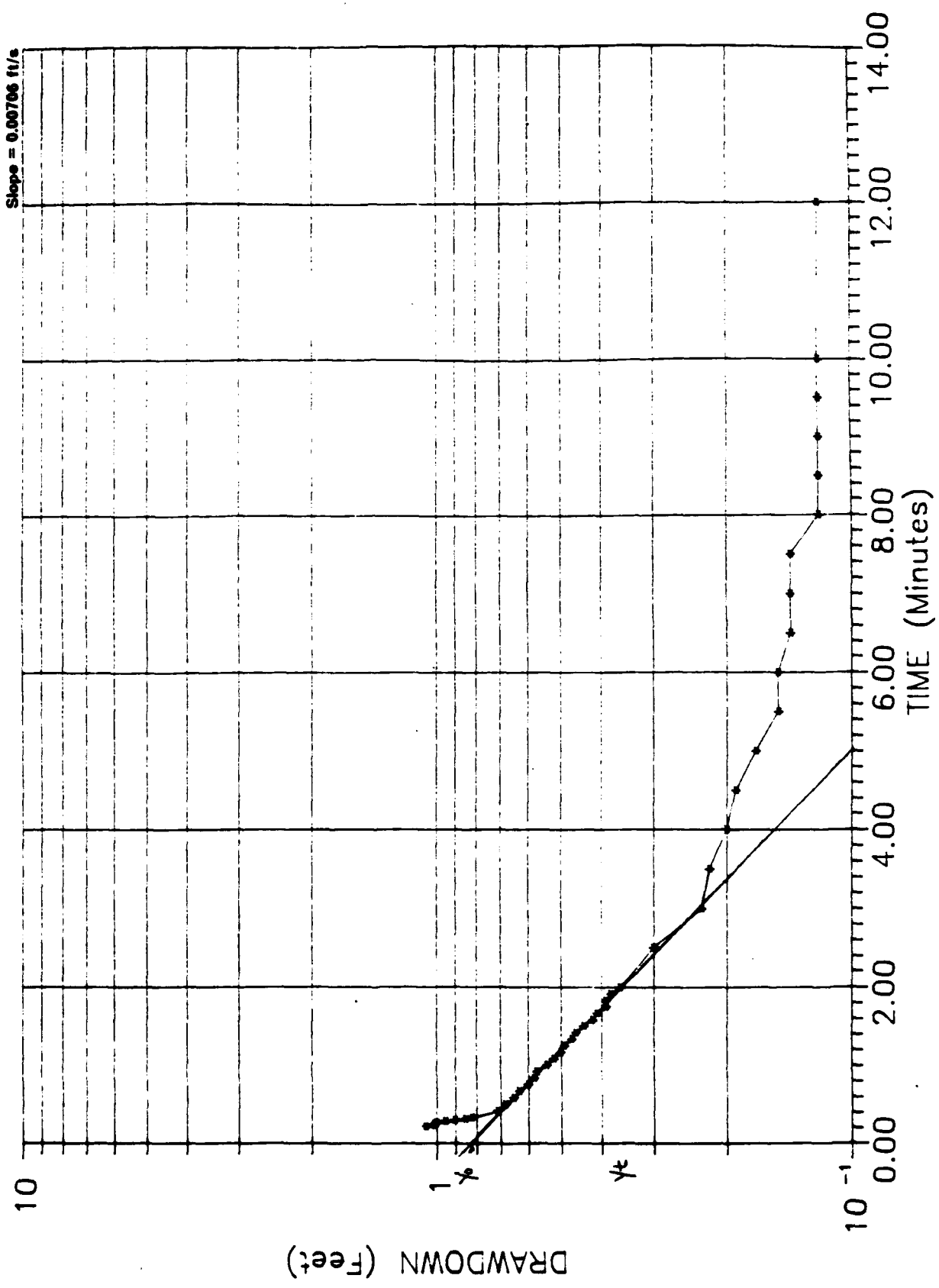
S9-4



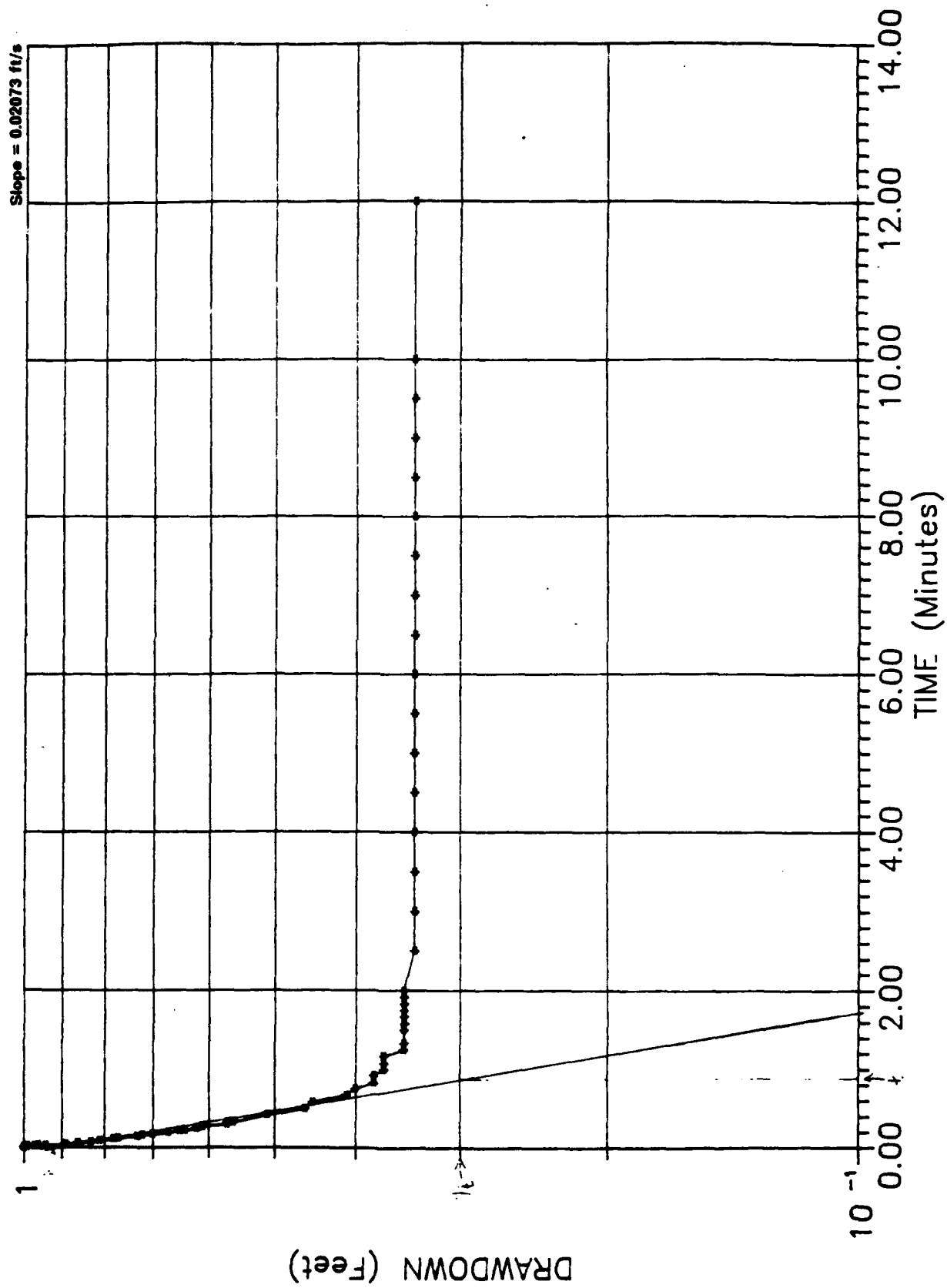
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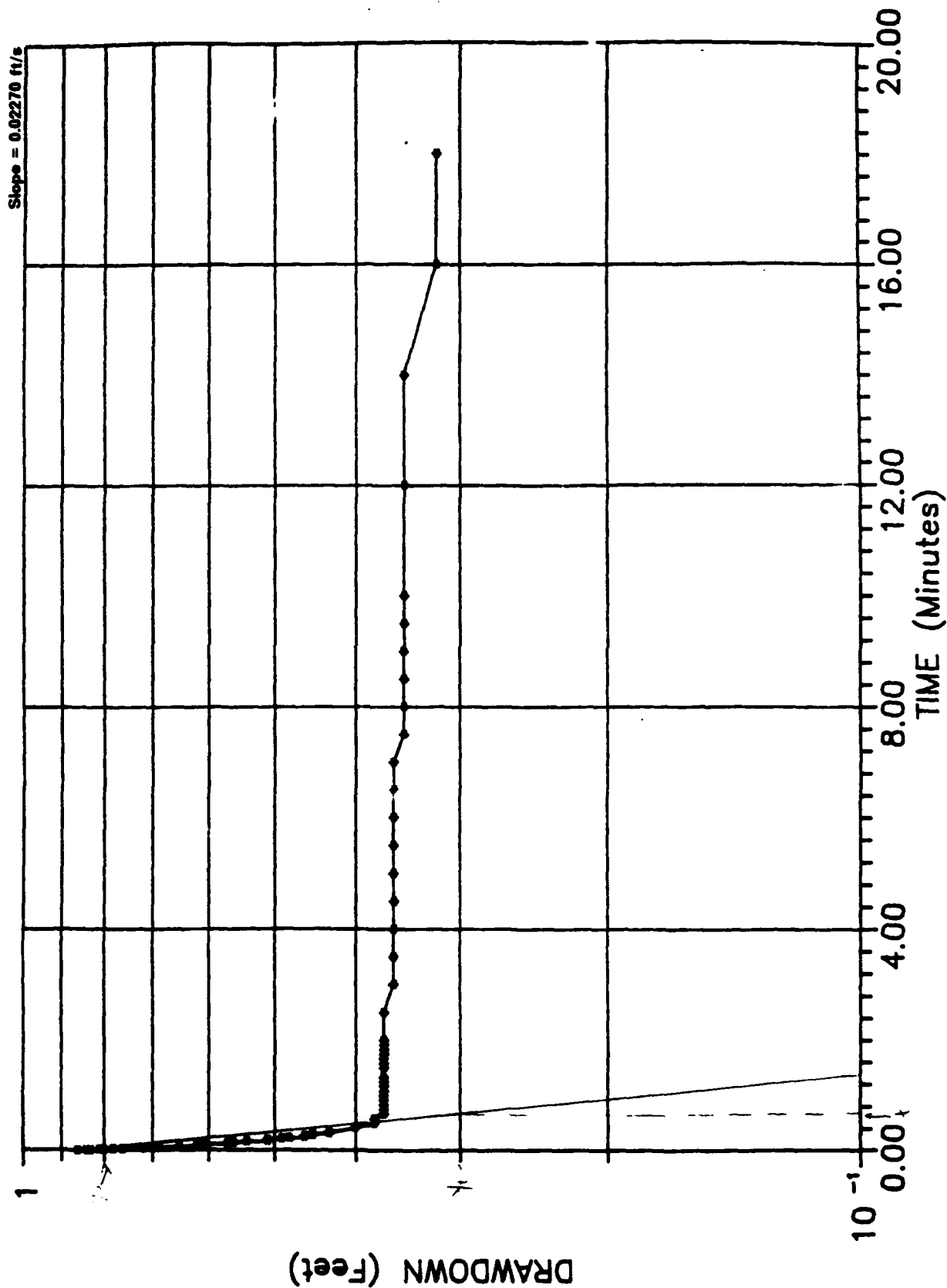
S12-3



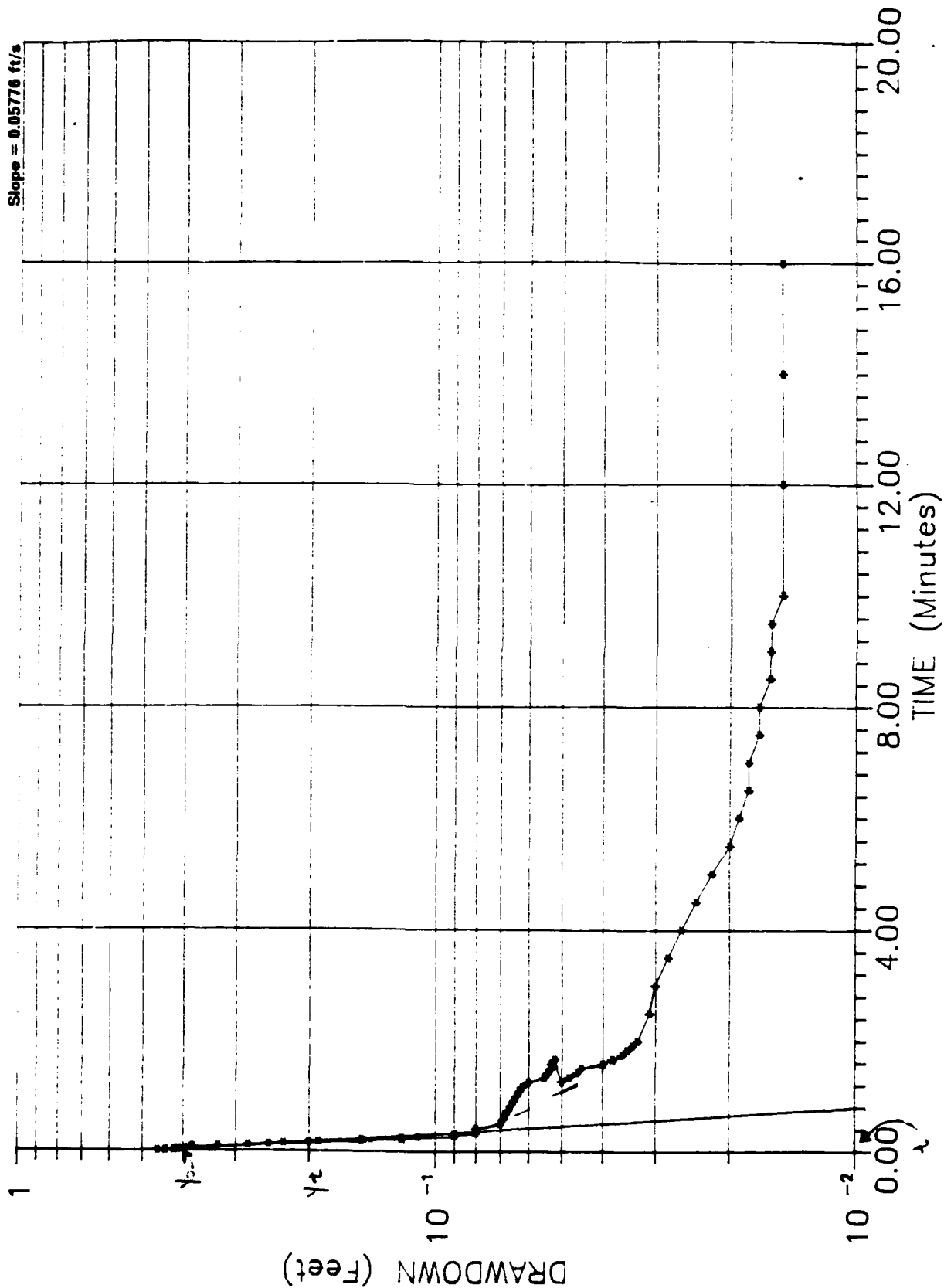
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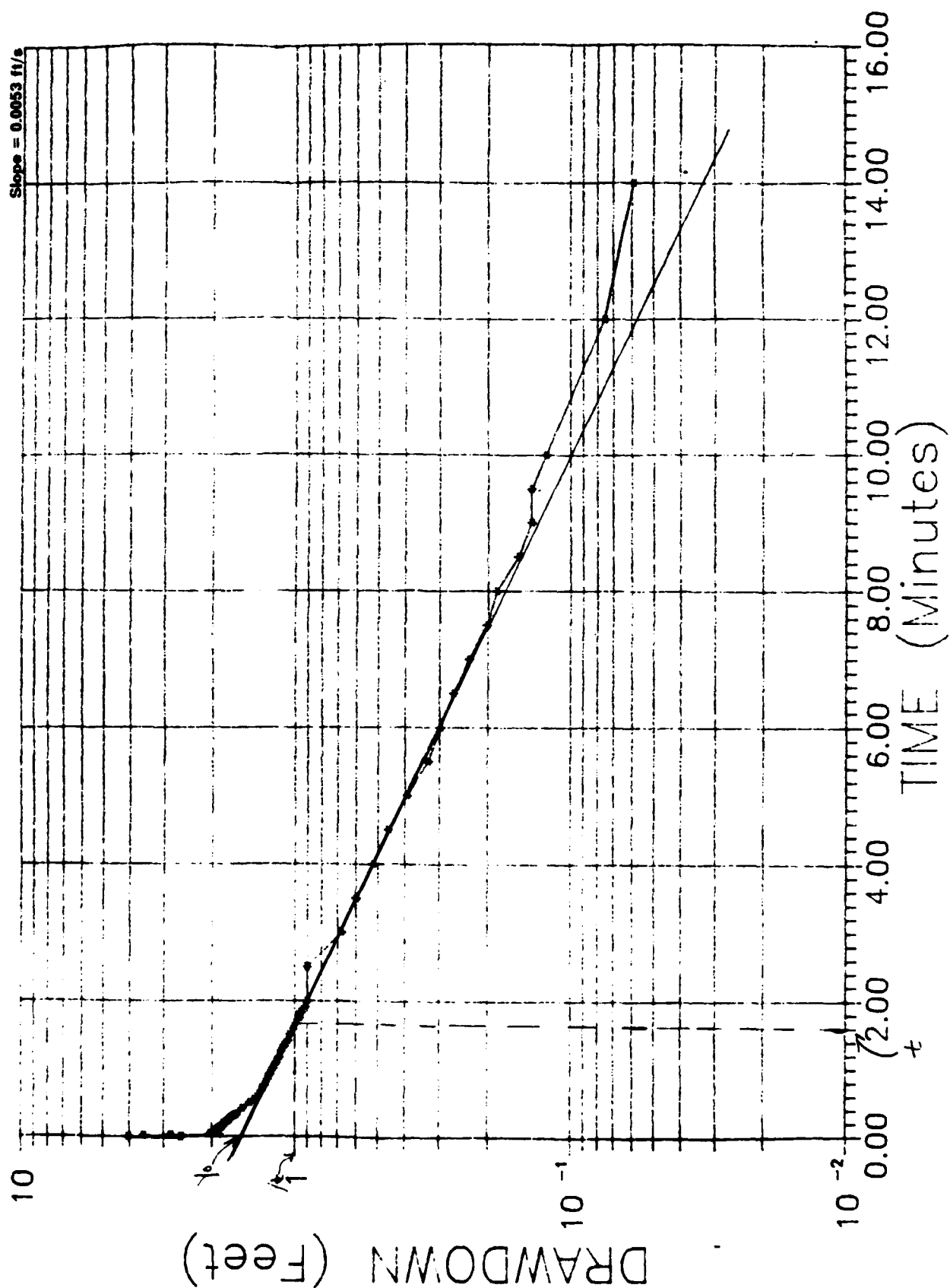
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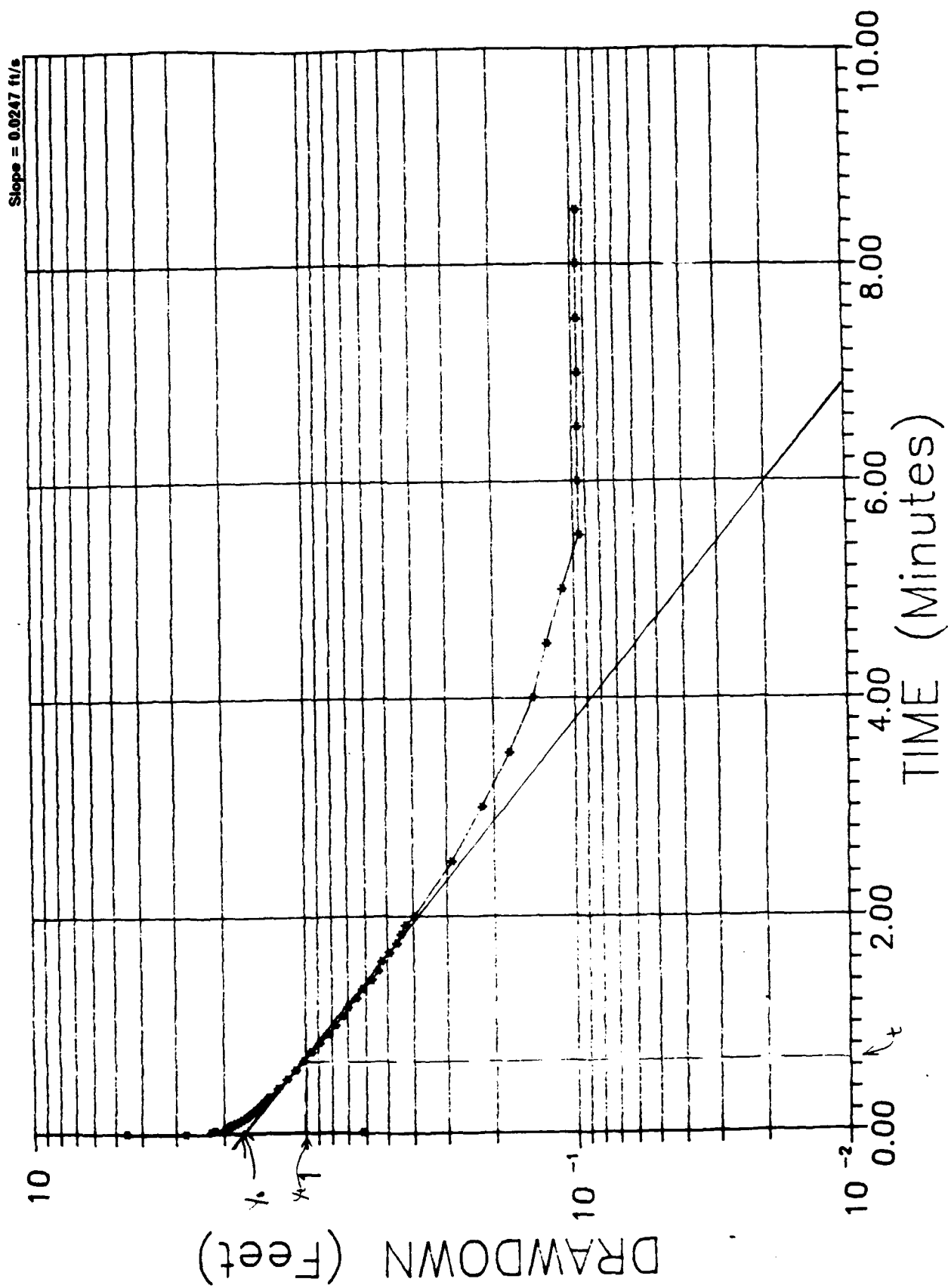
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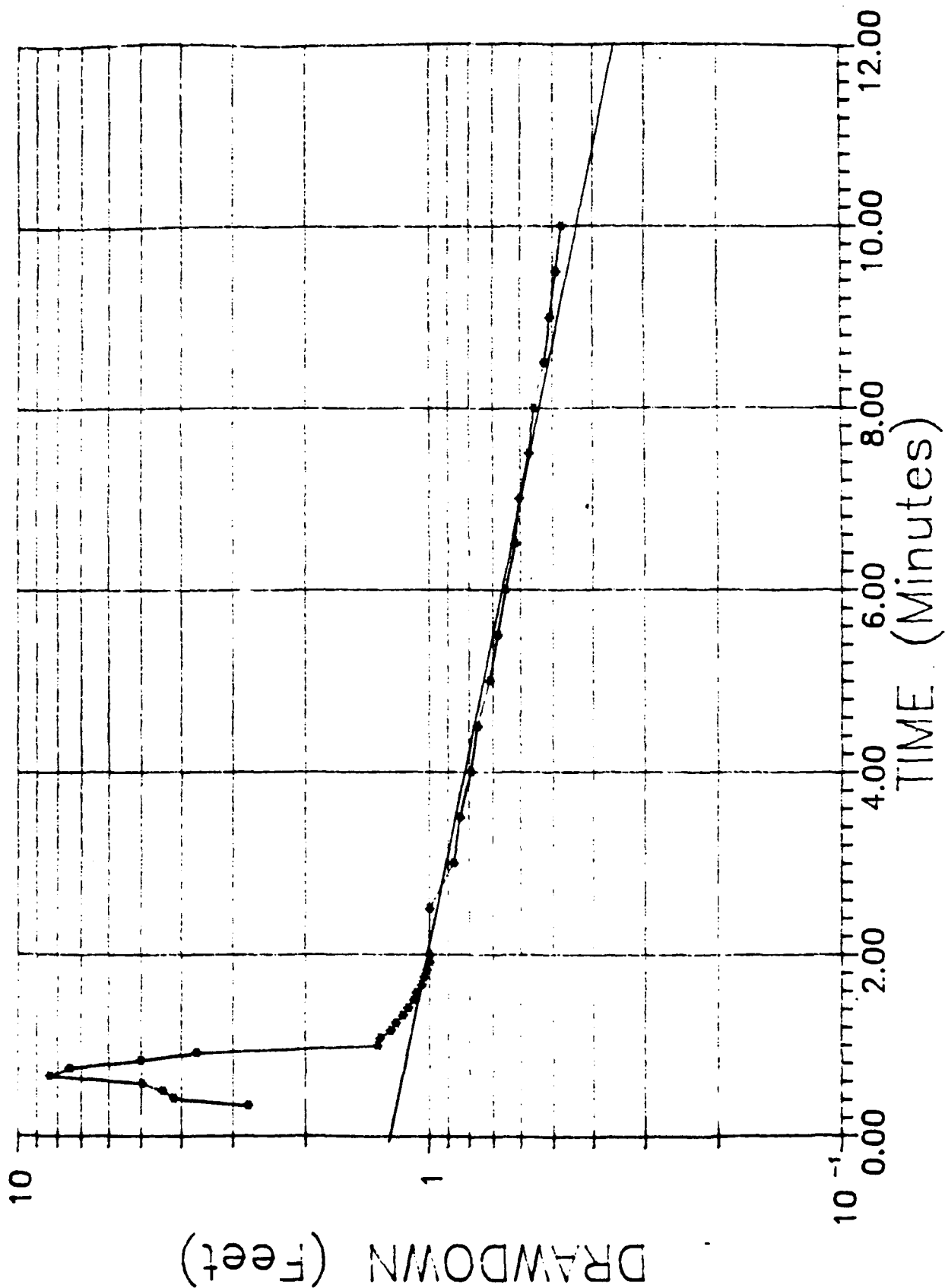
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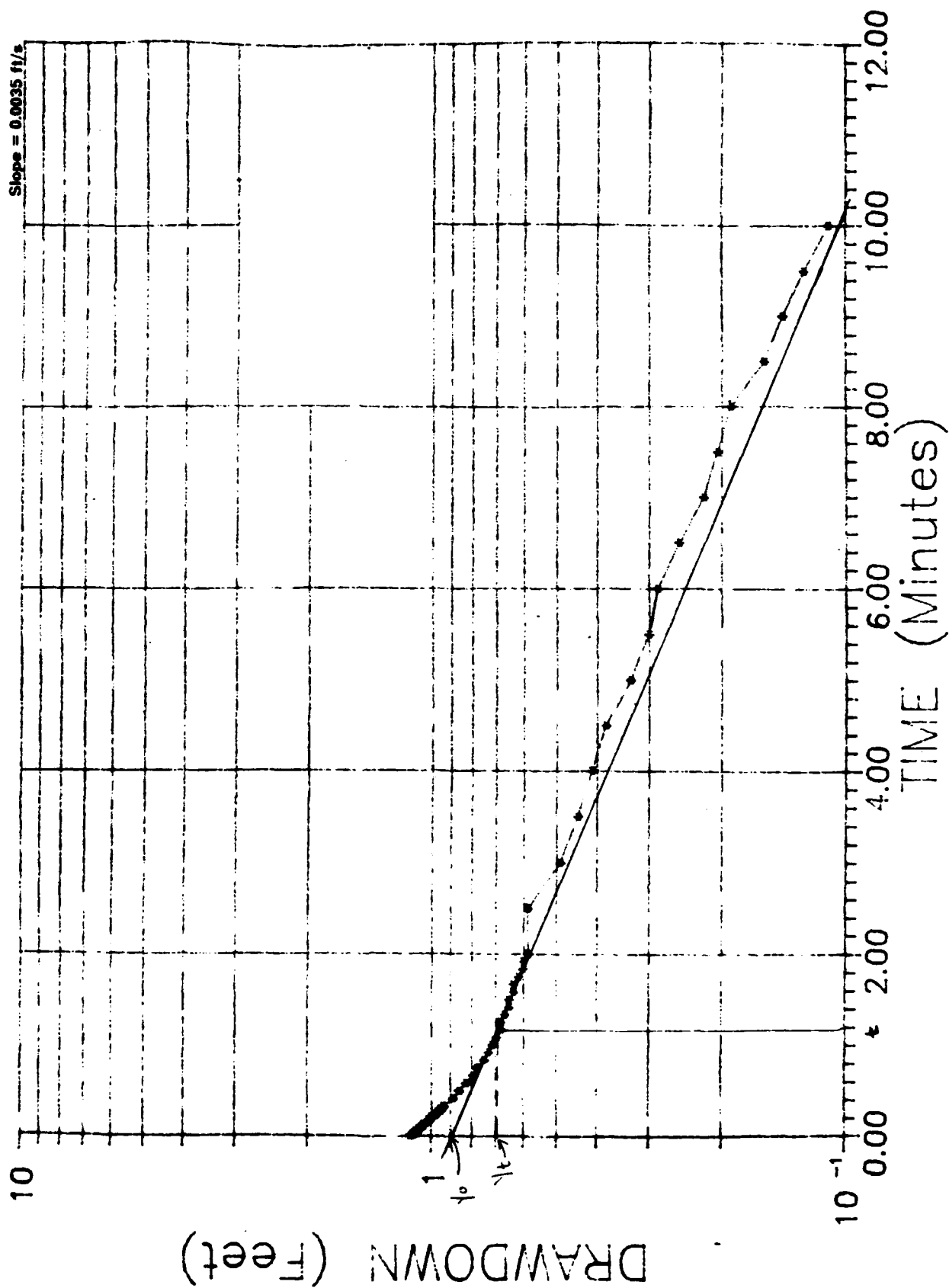
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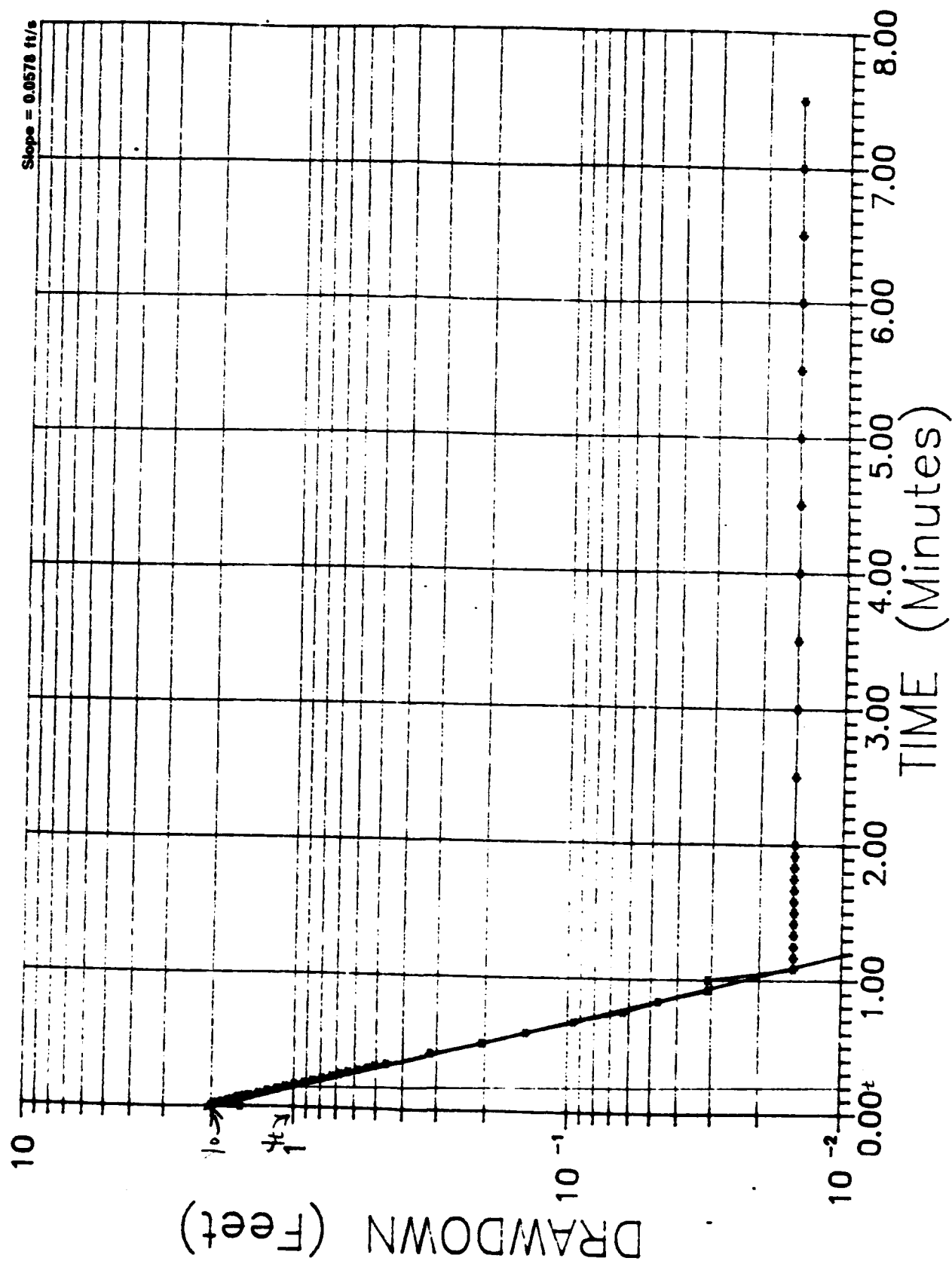
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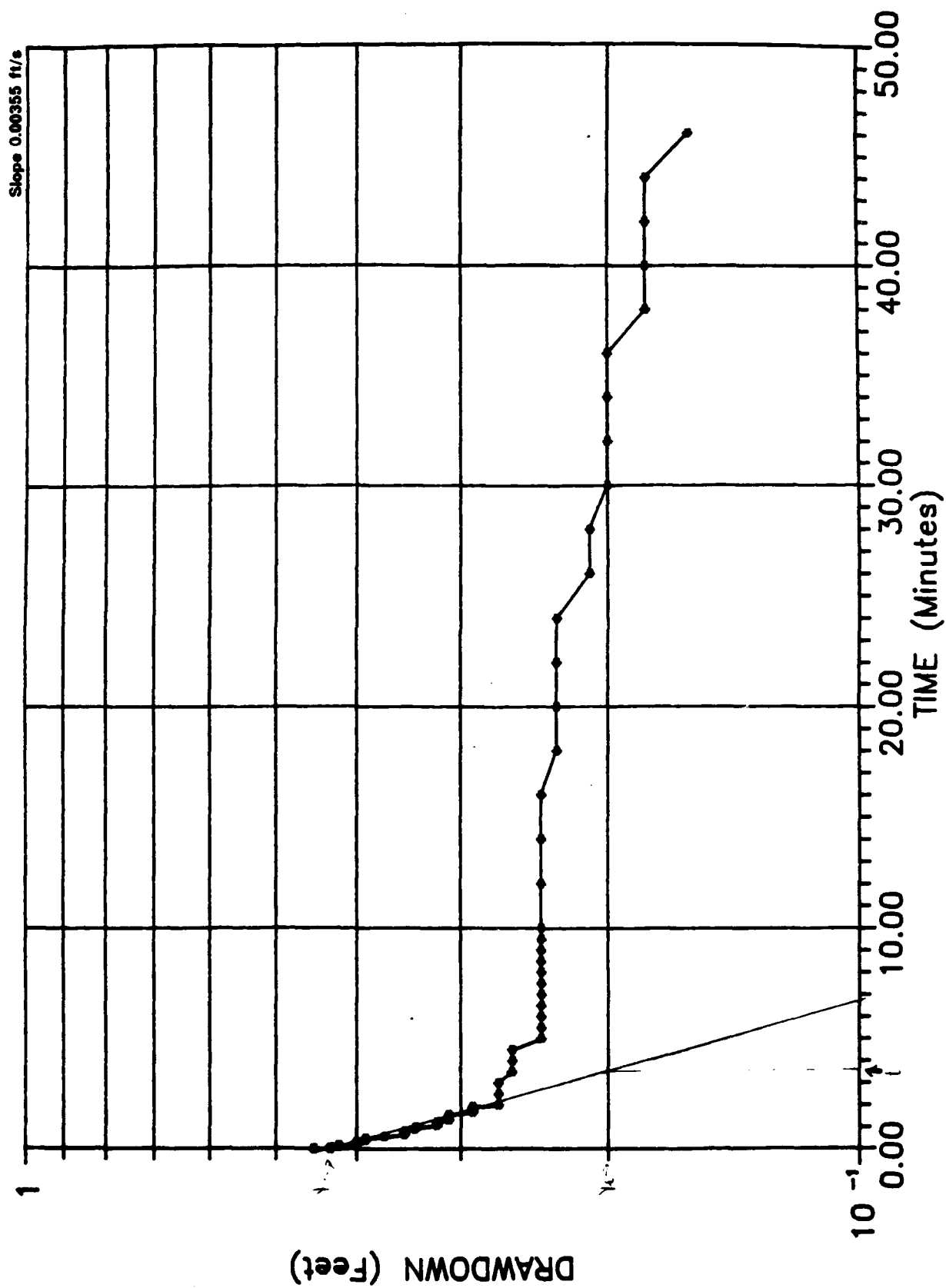
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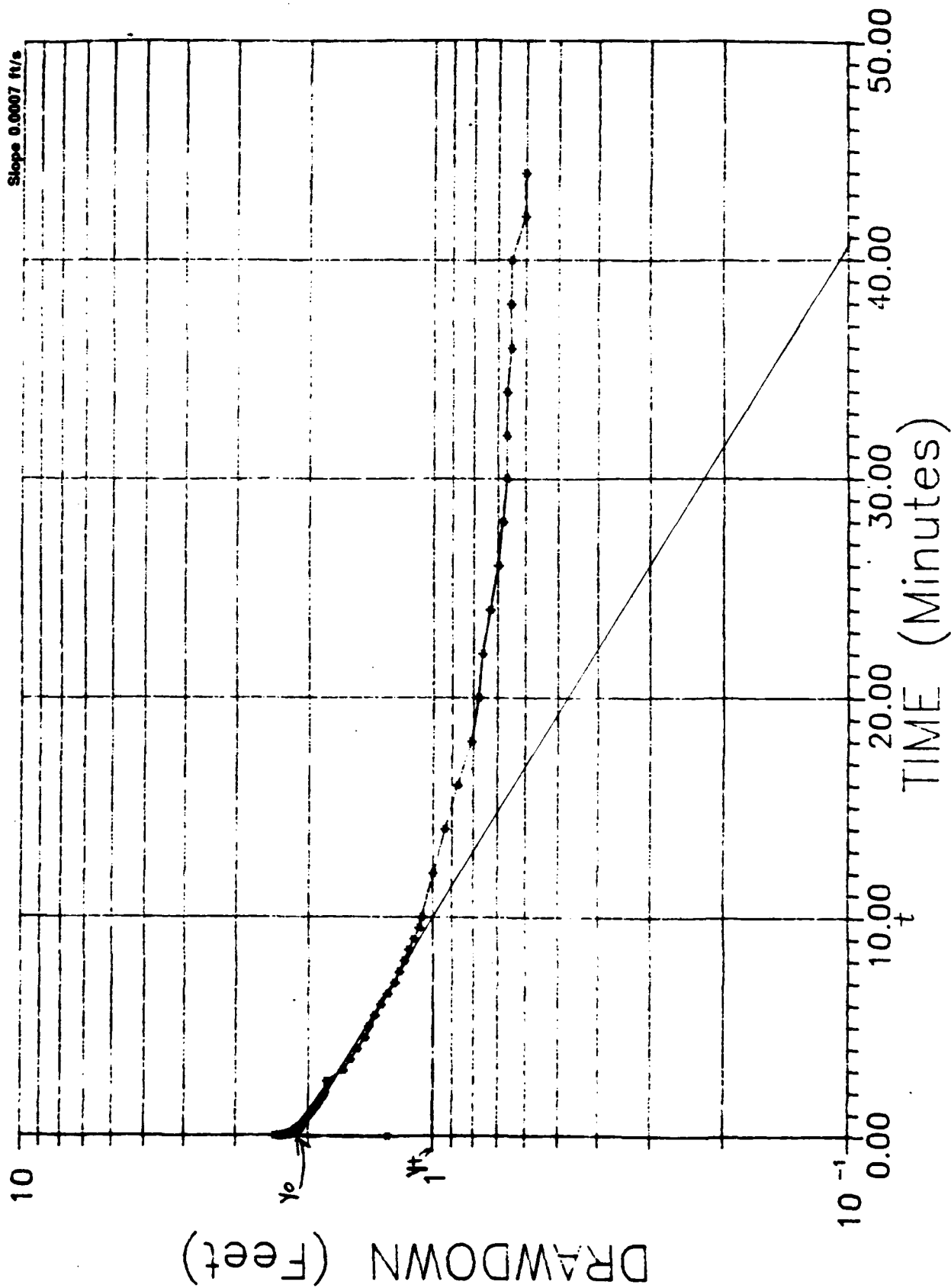
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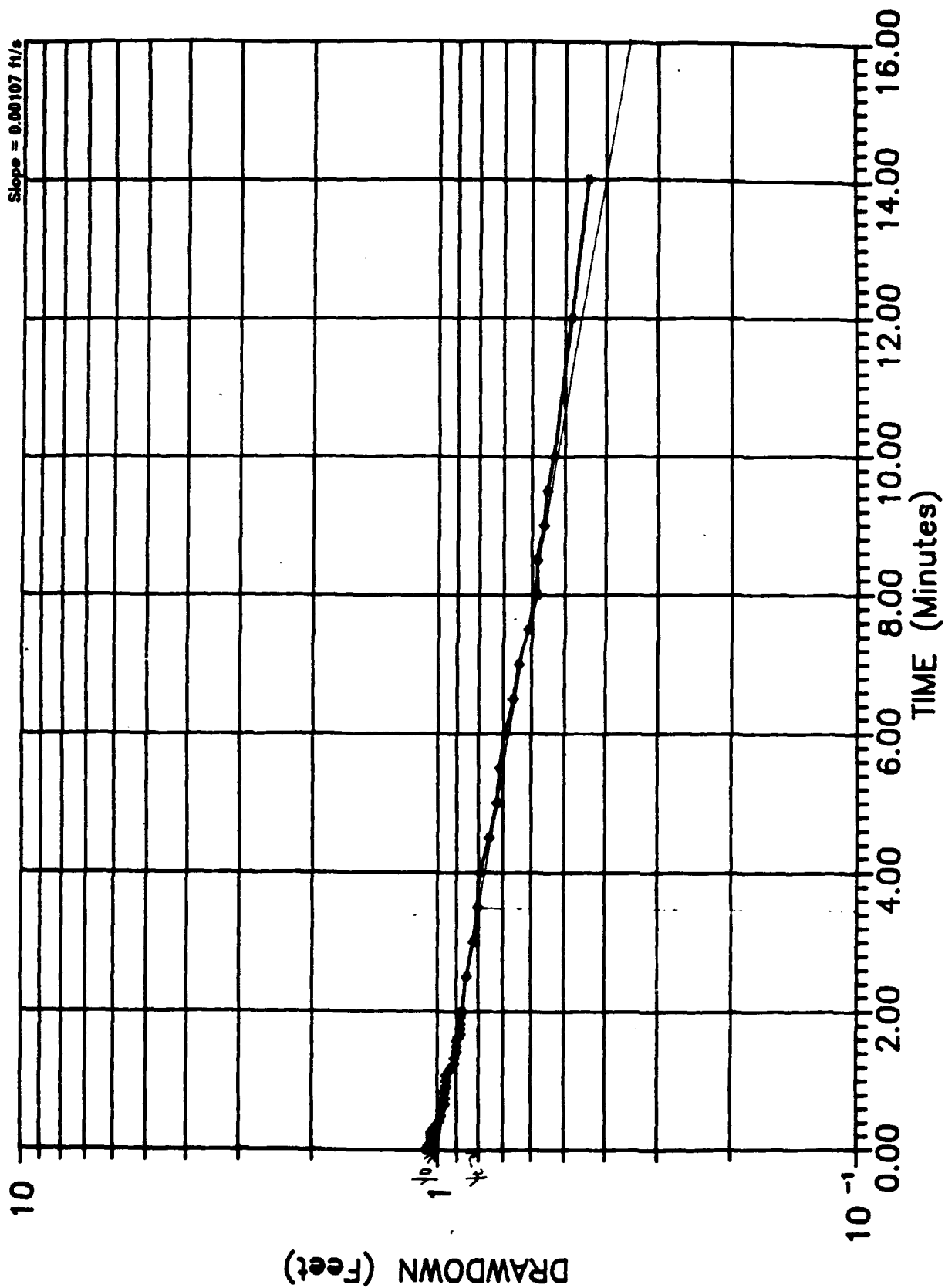
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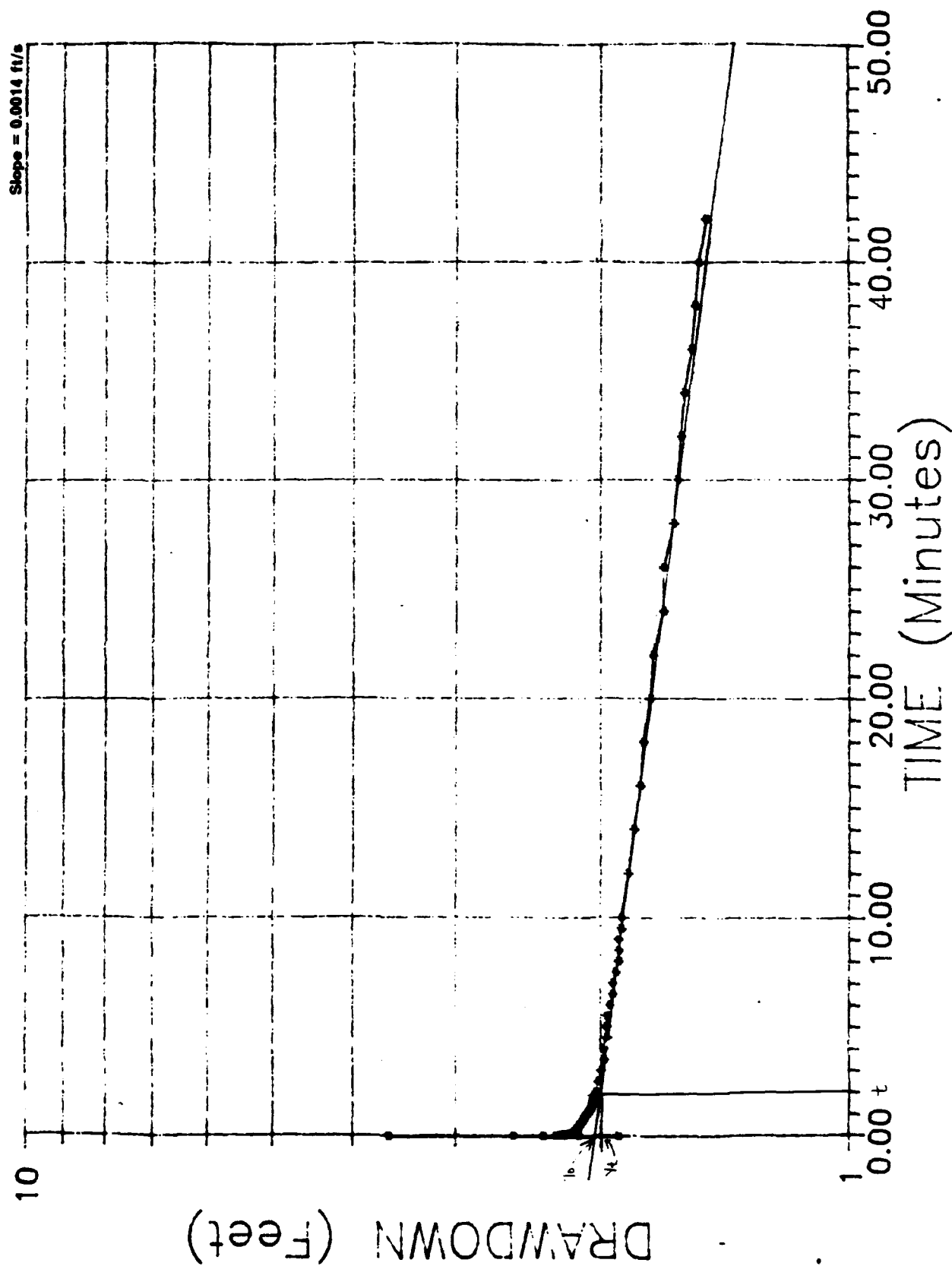
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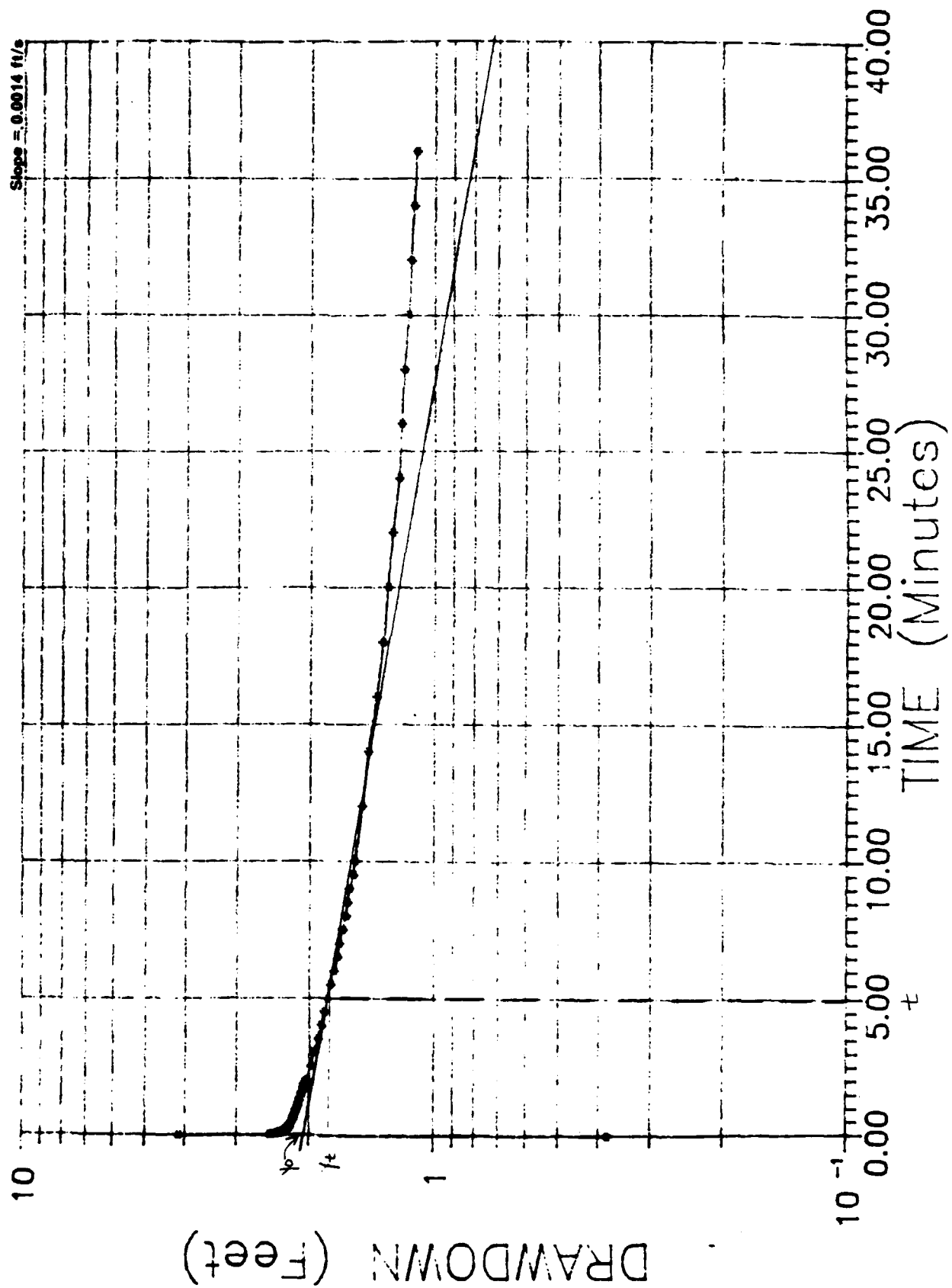
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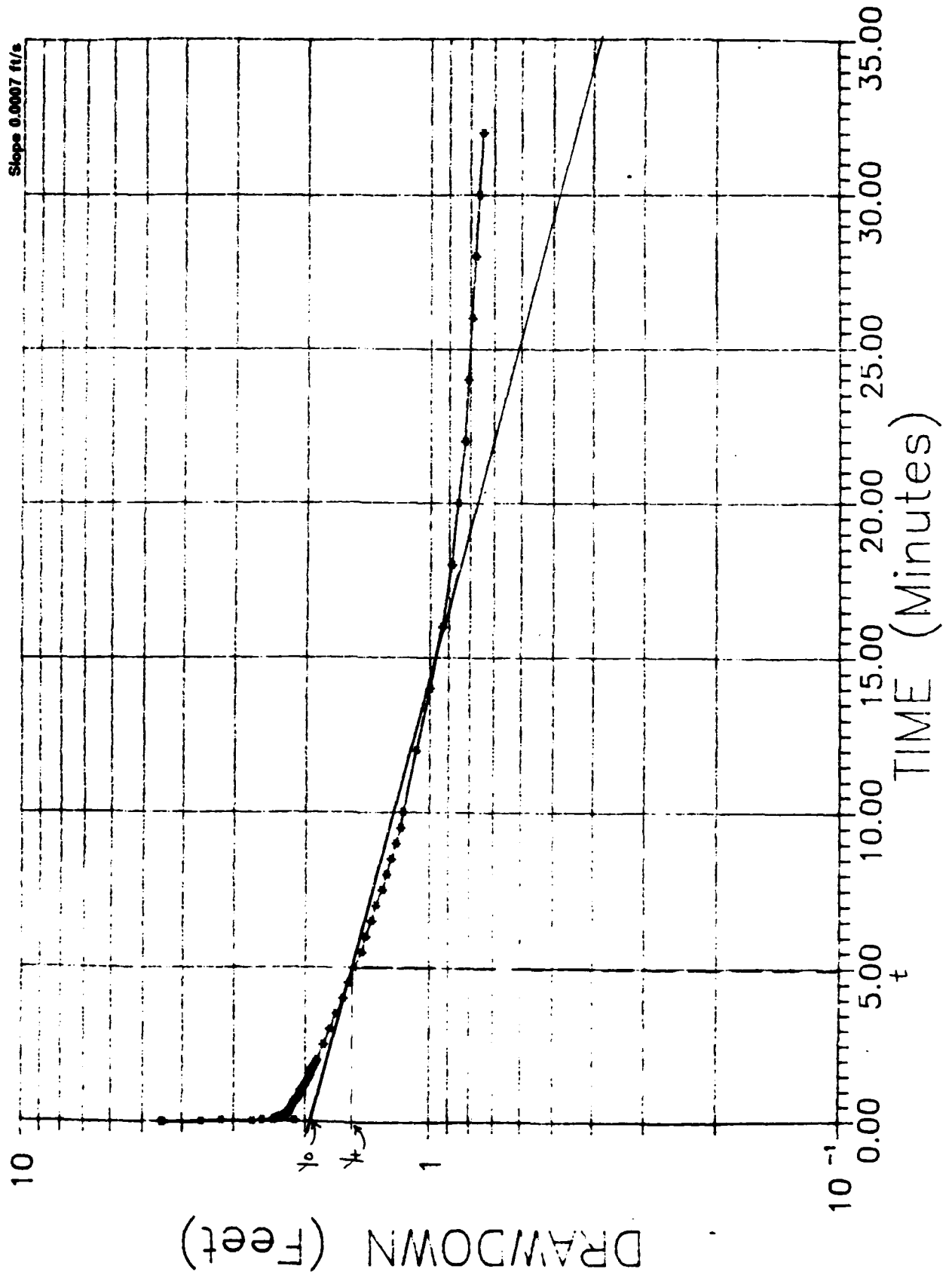
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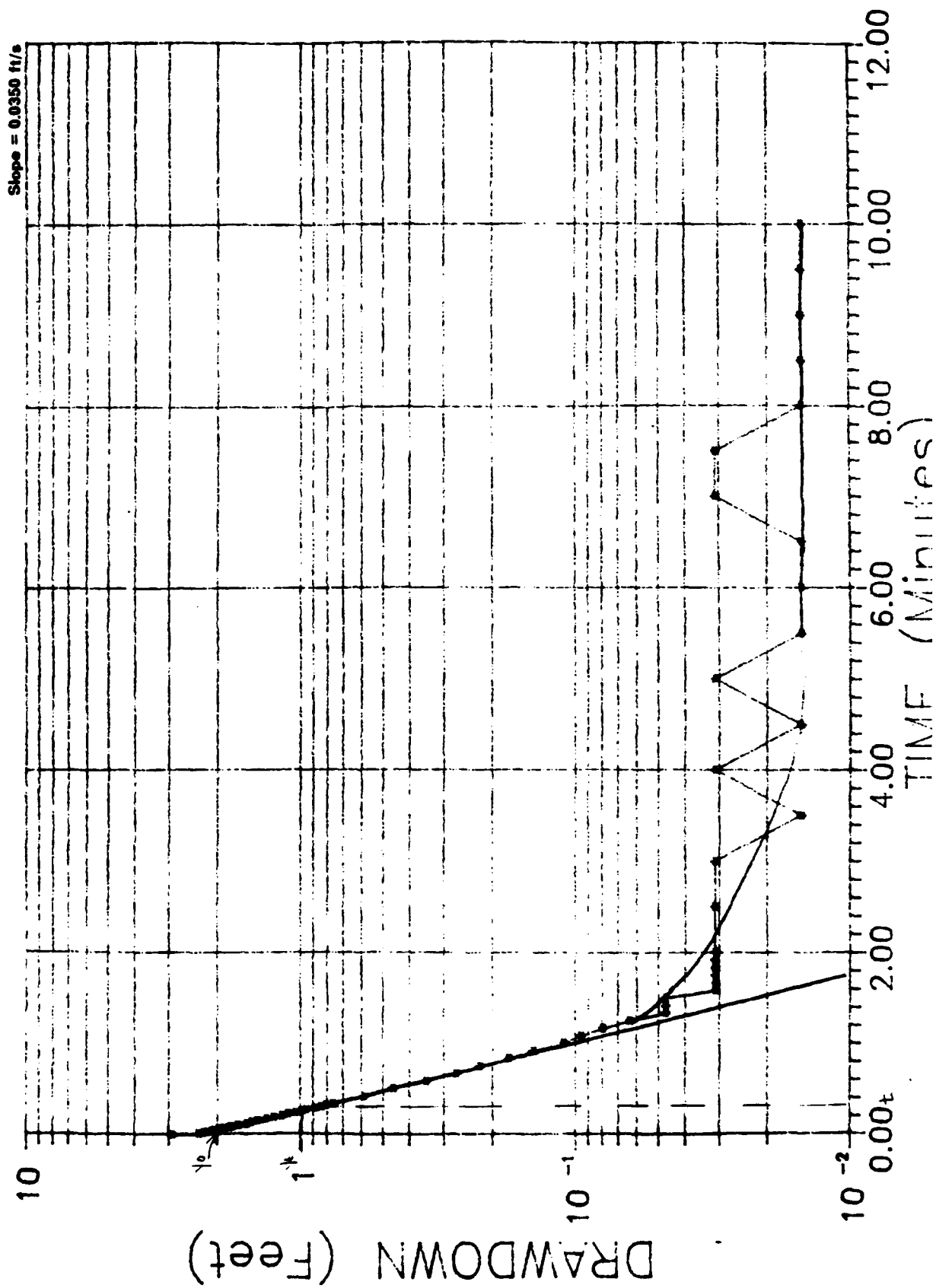
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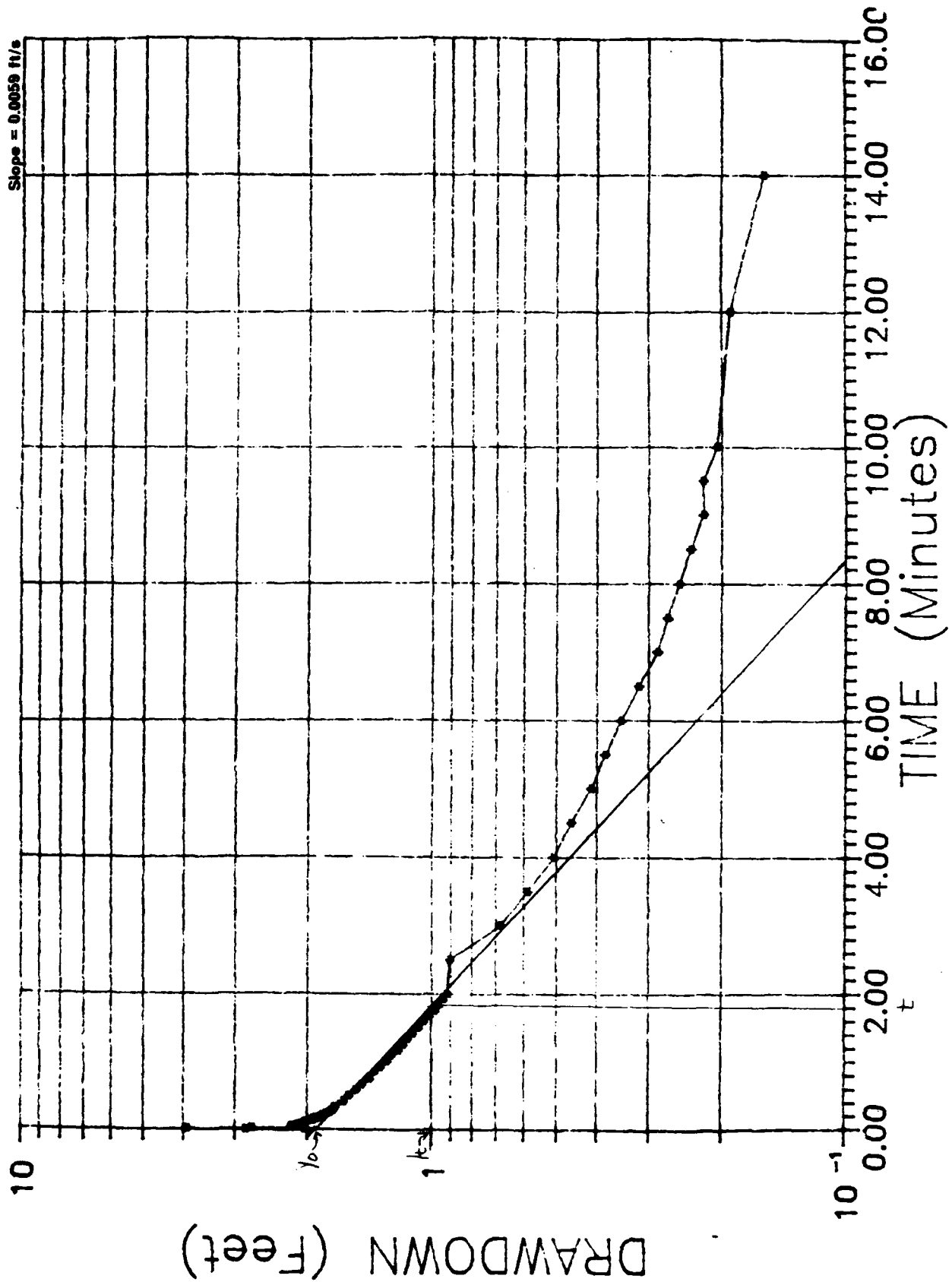
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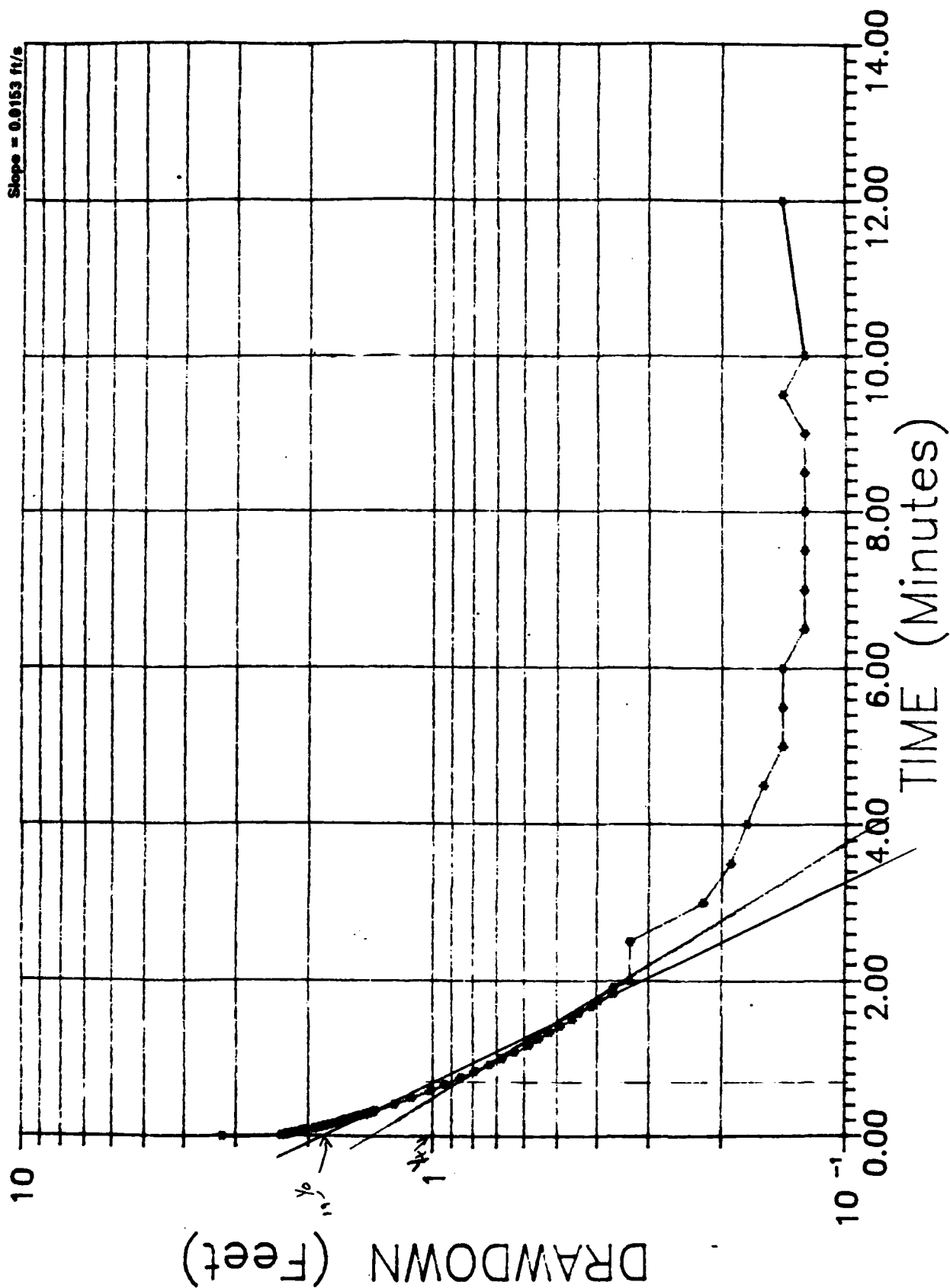
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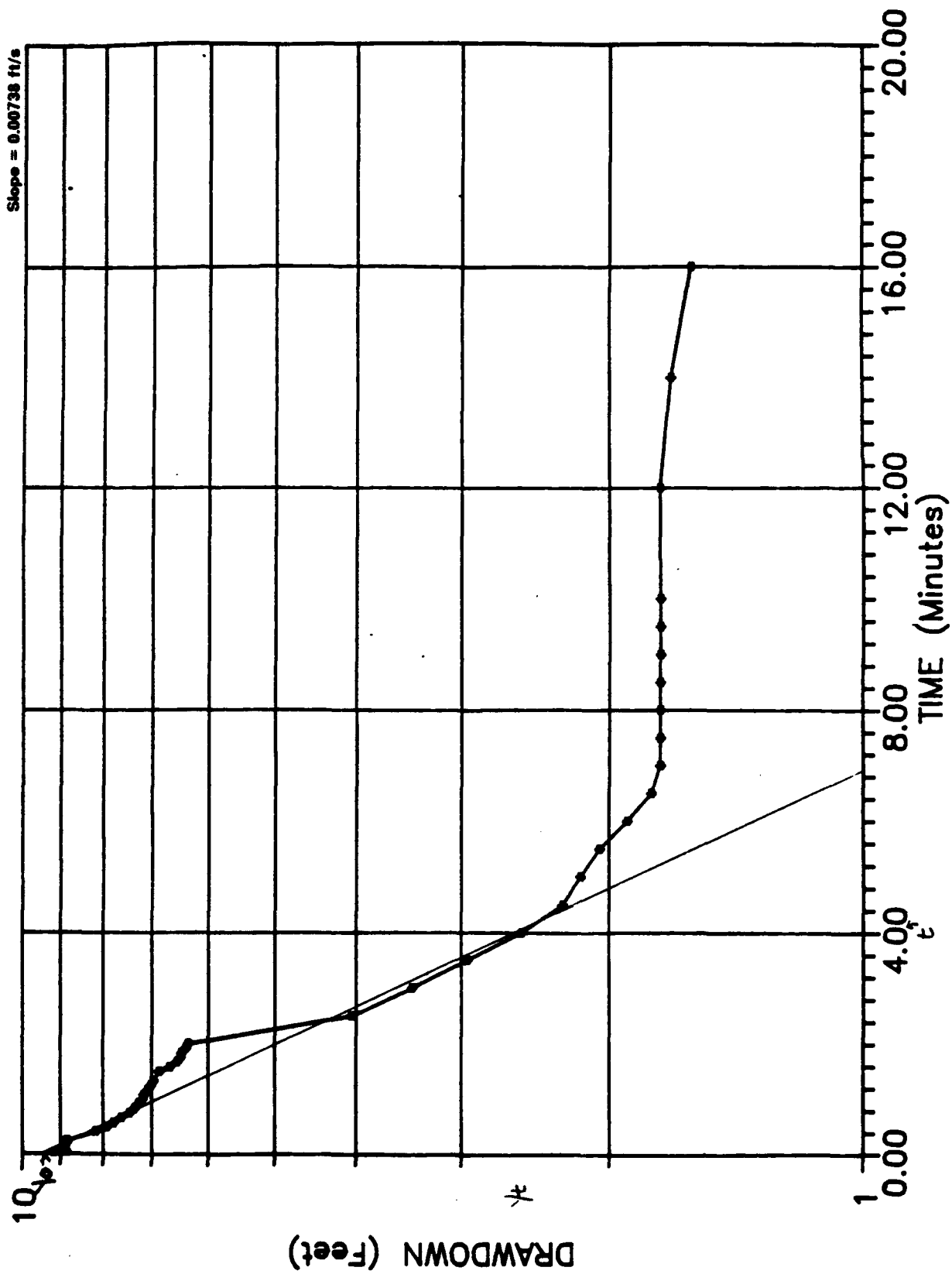
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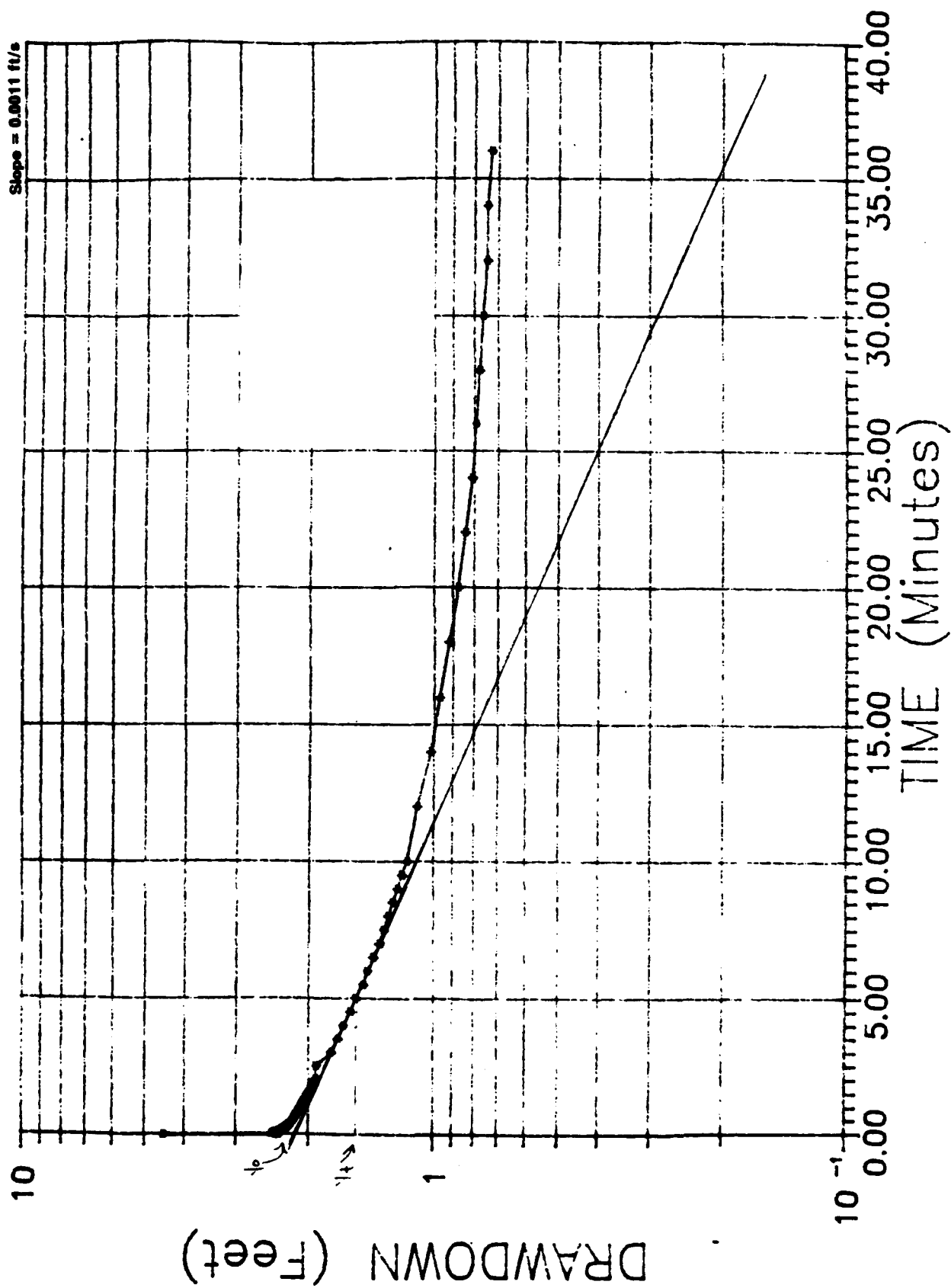
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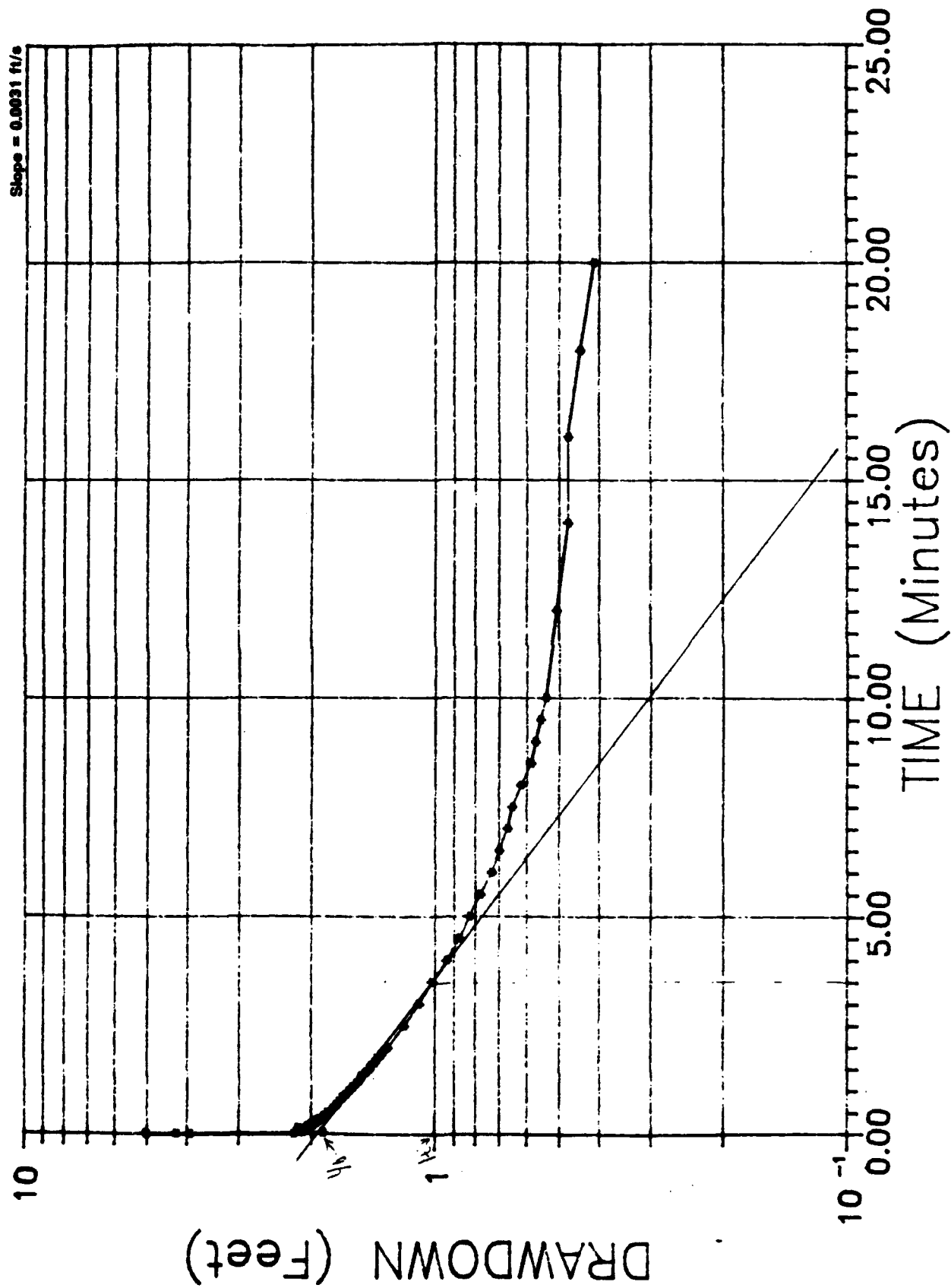
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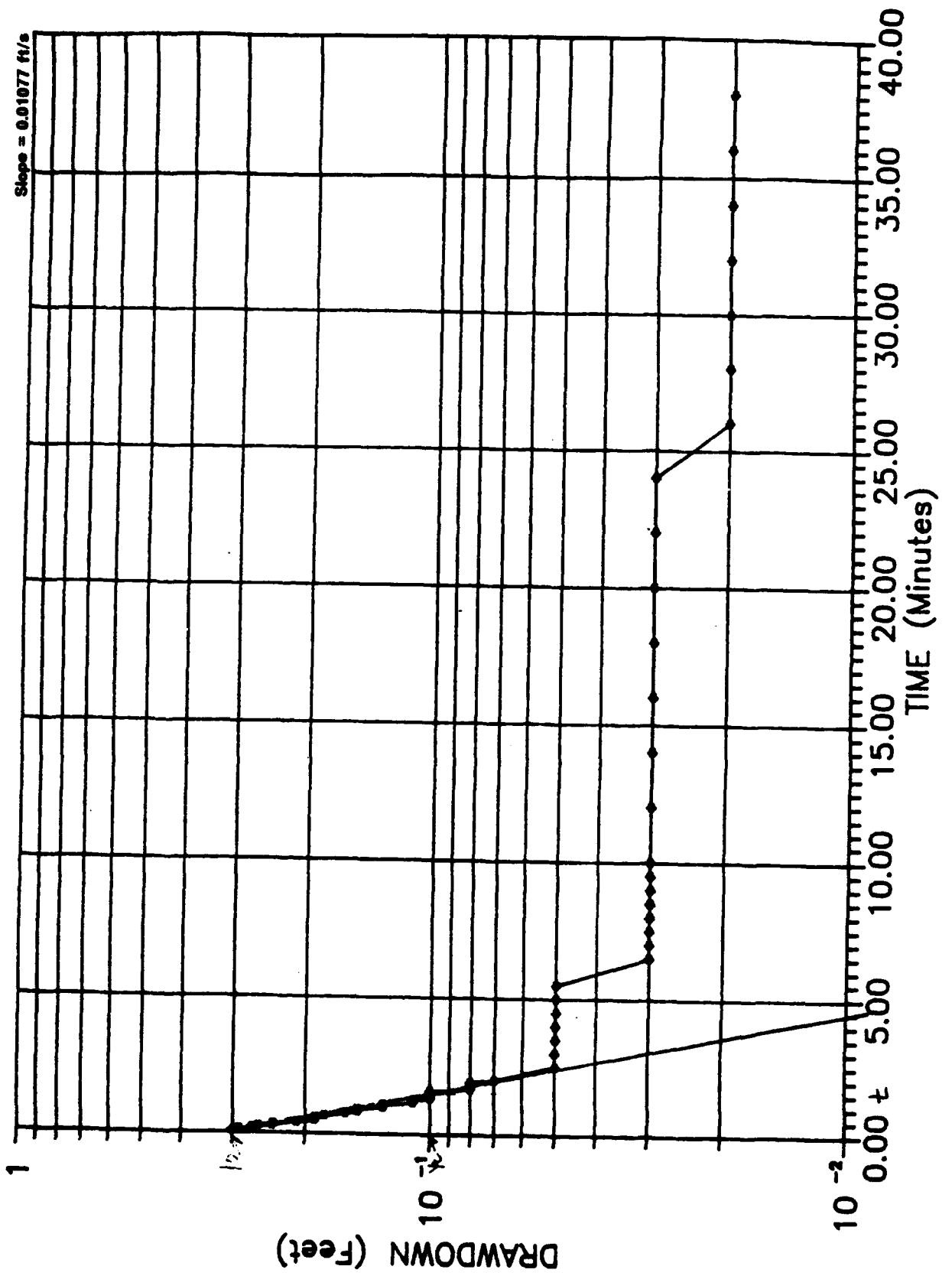
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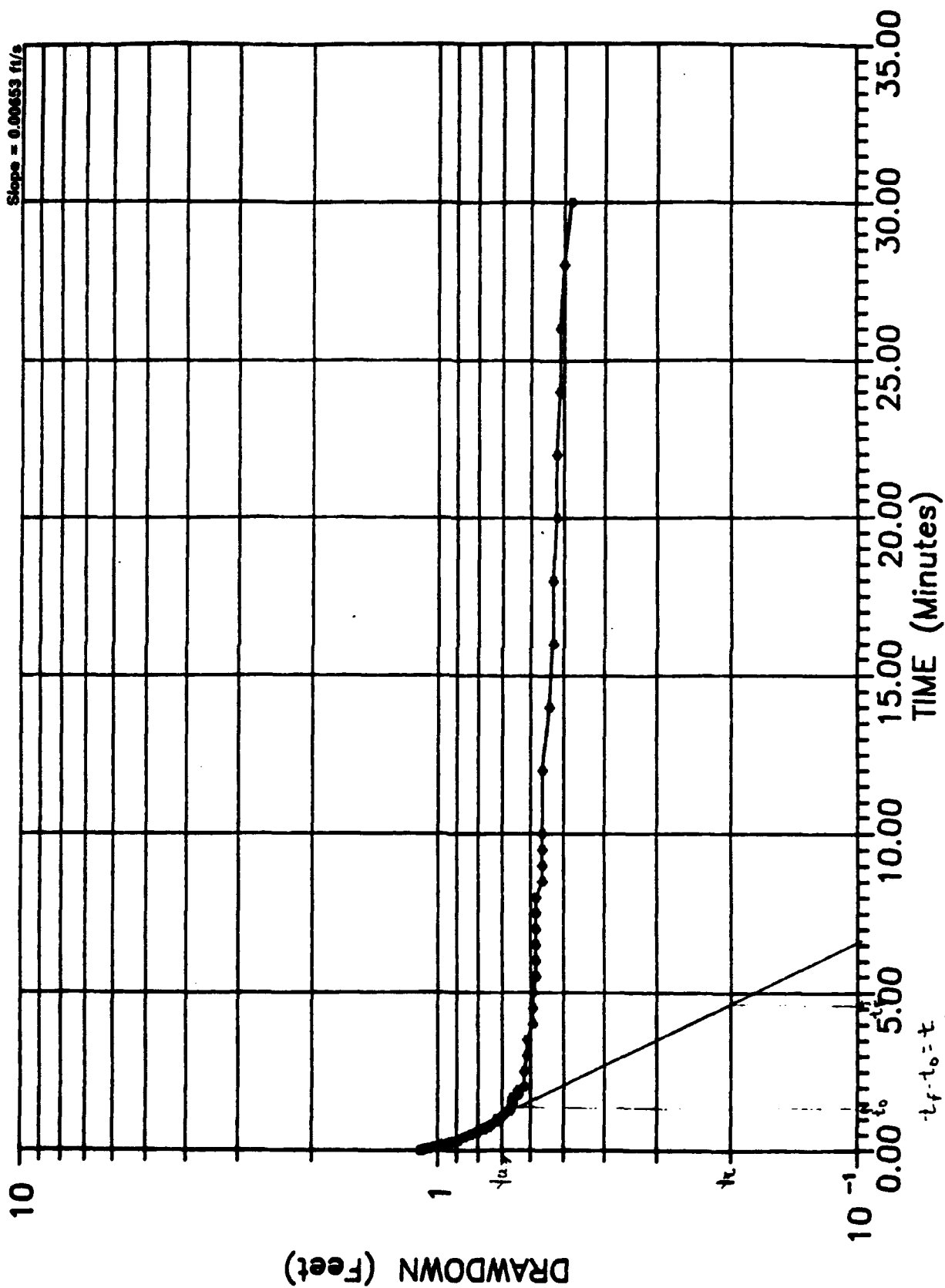
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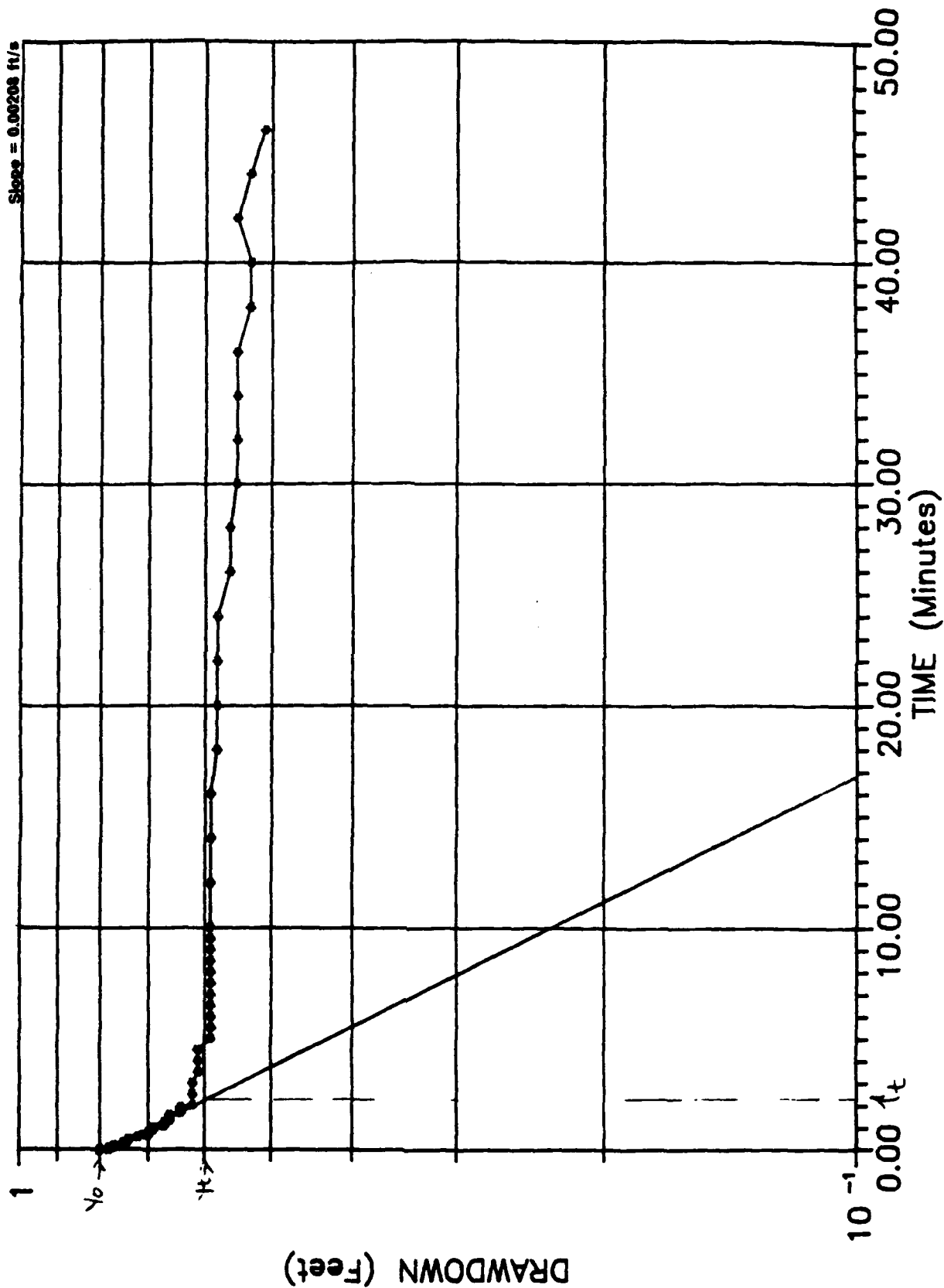
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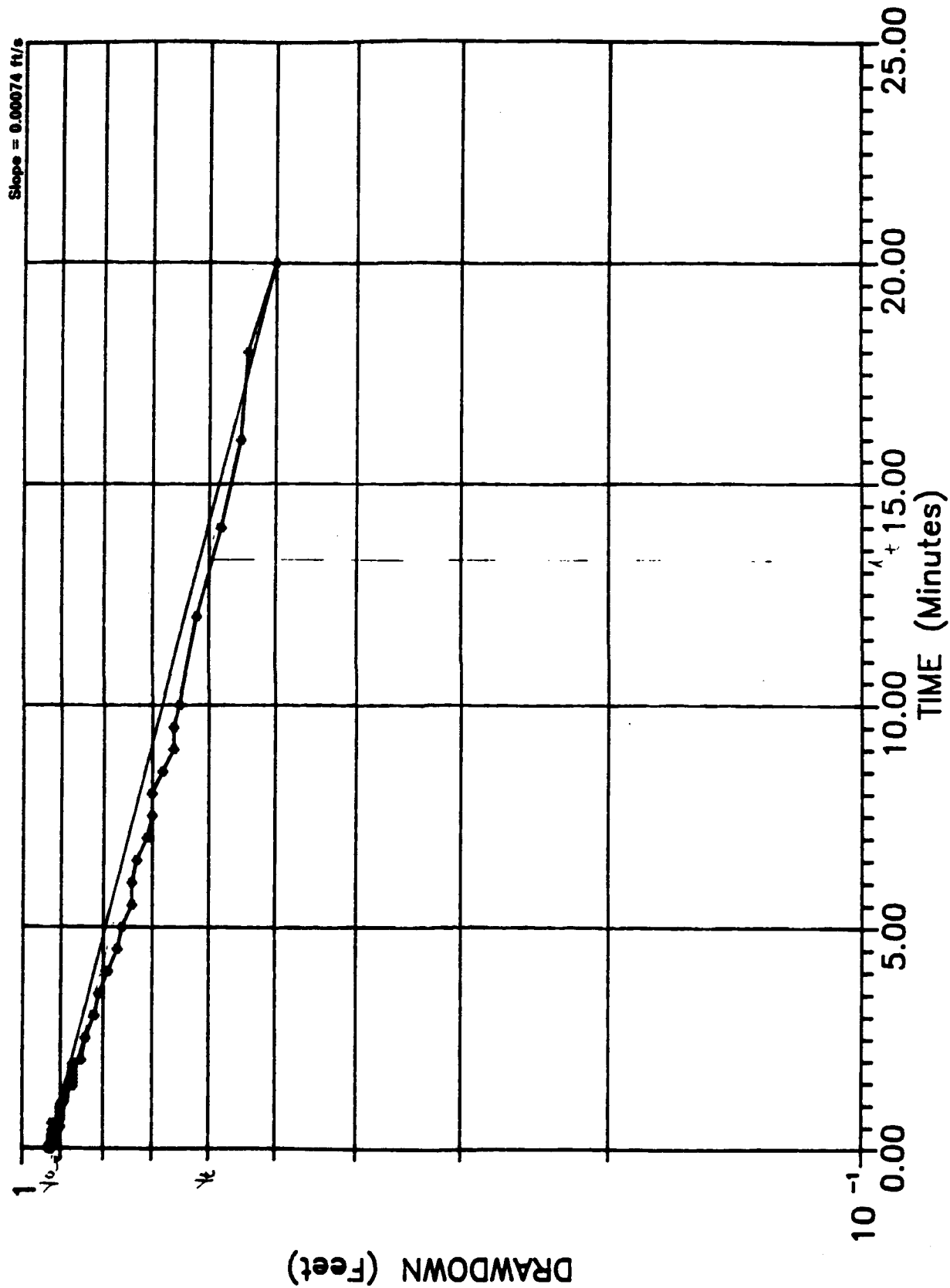
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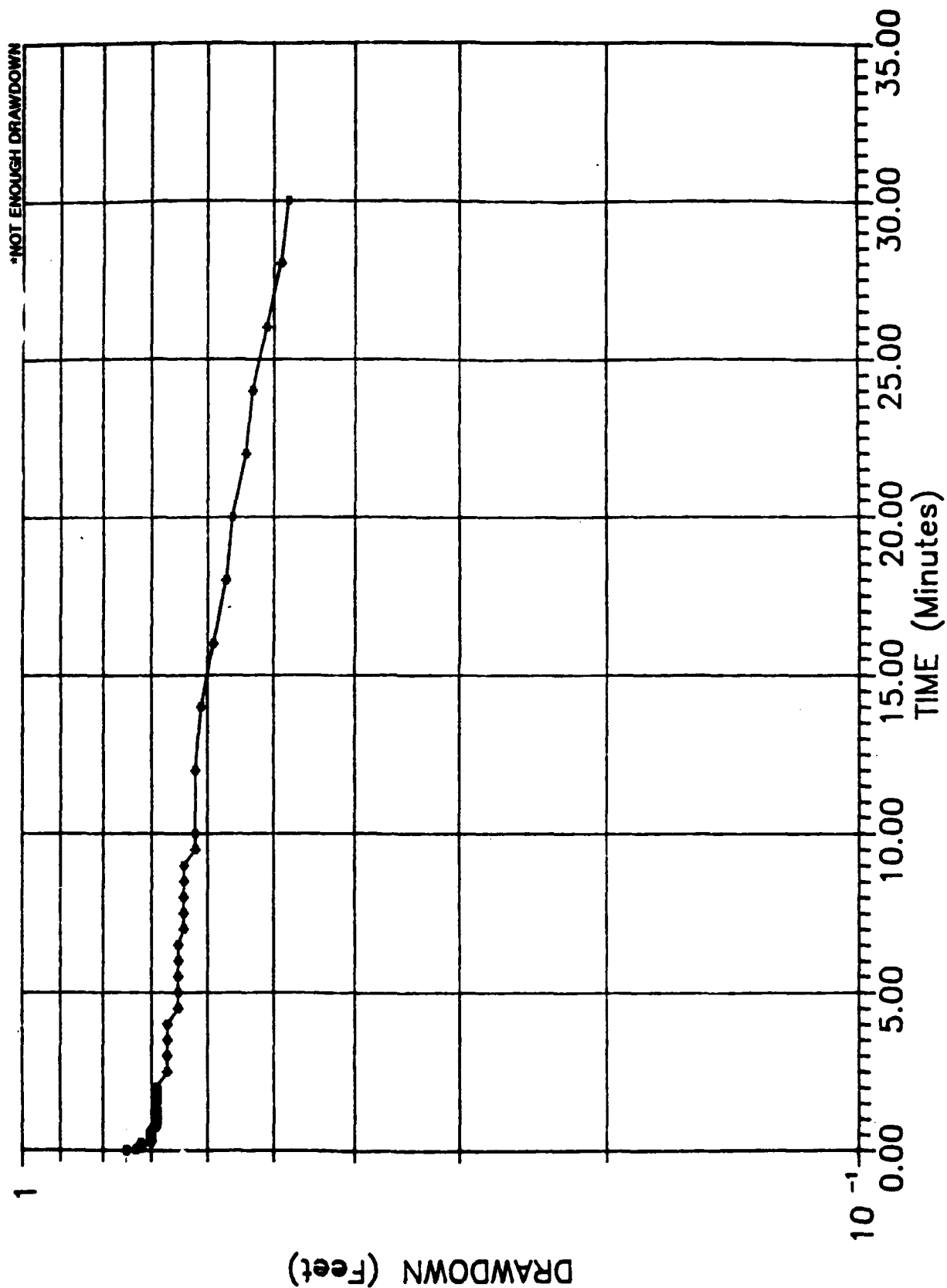
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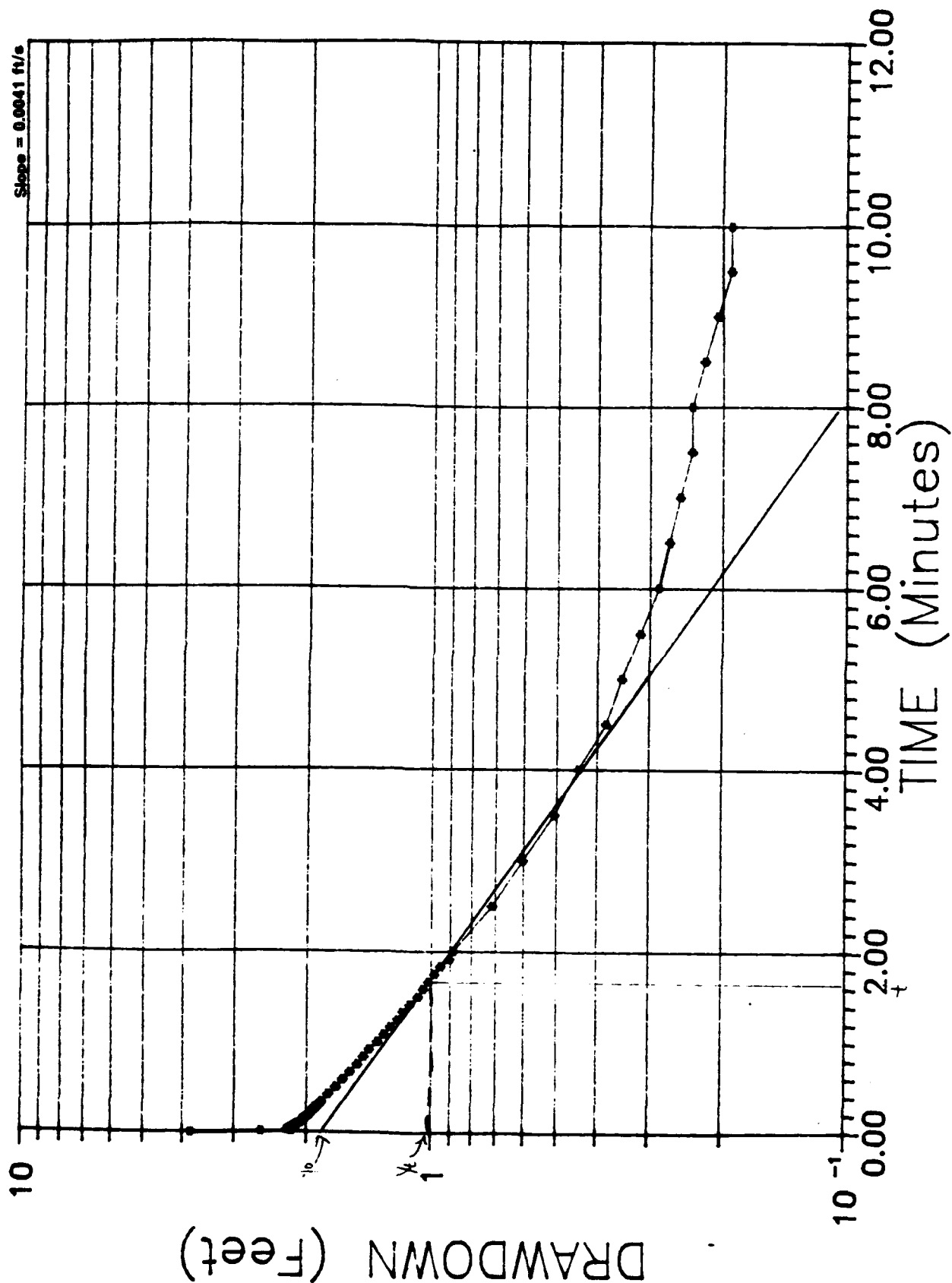
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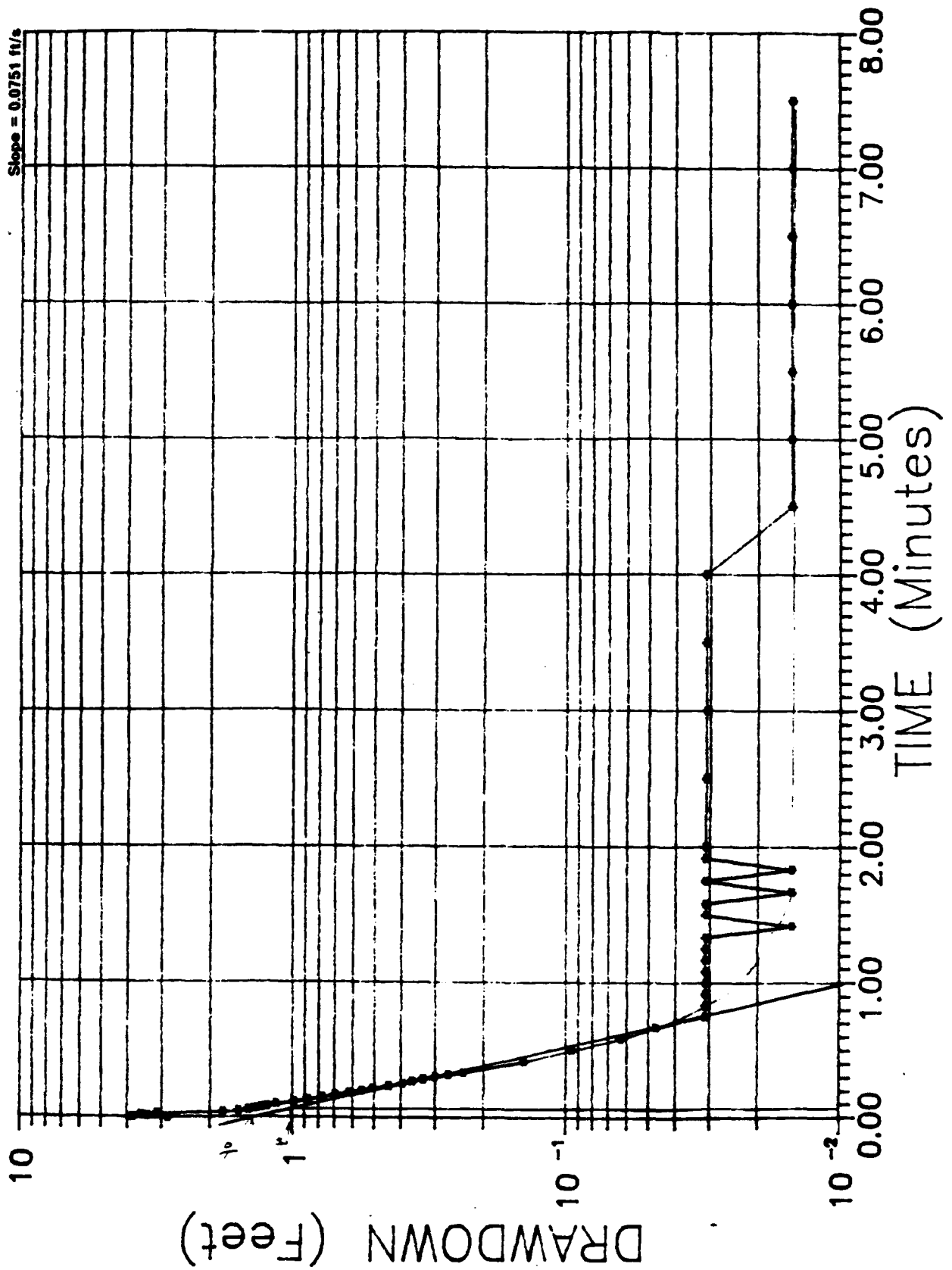
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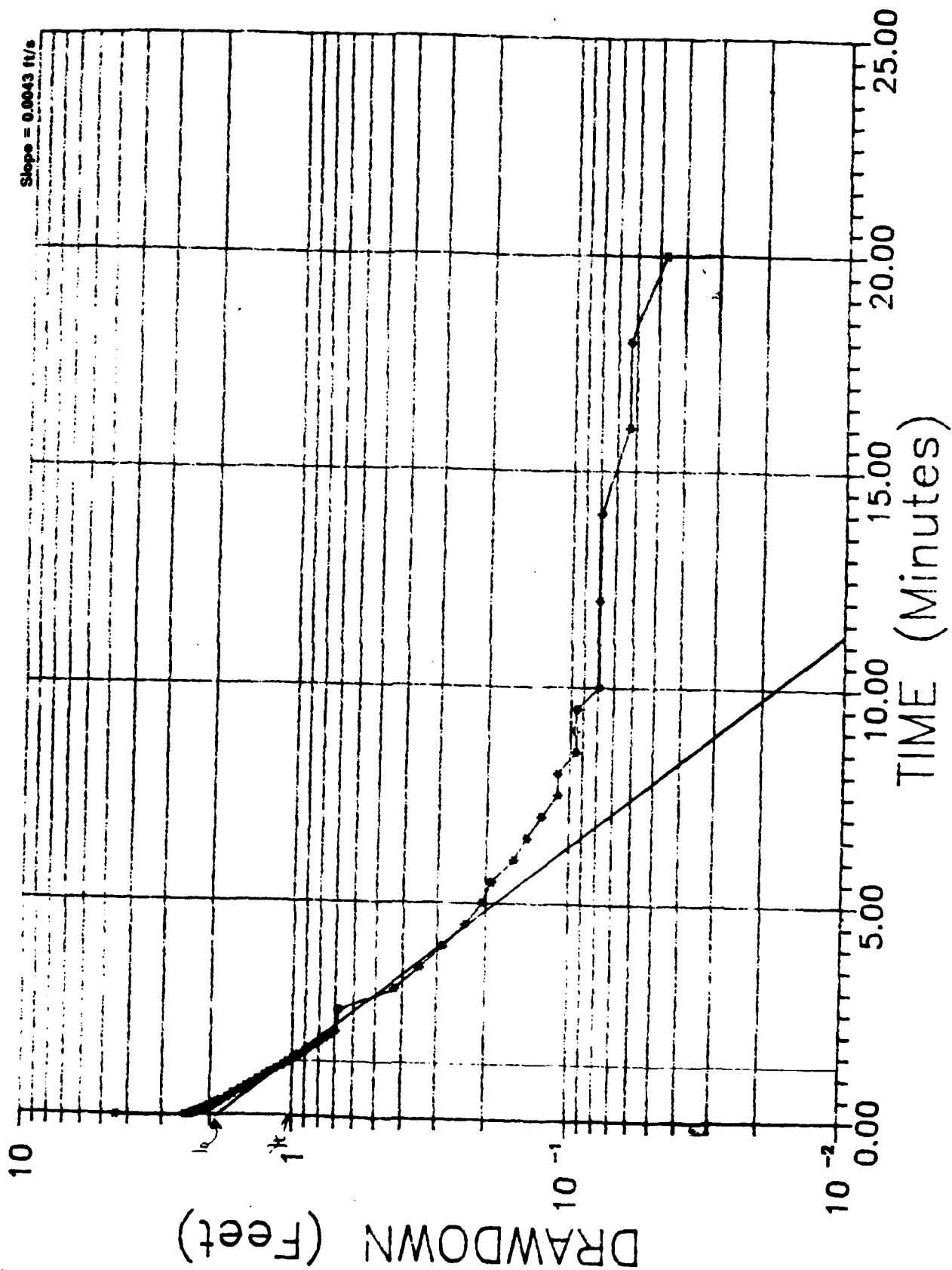
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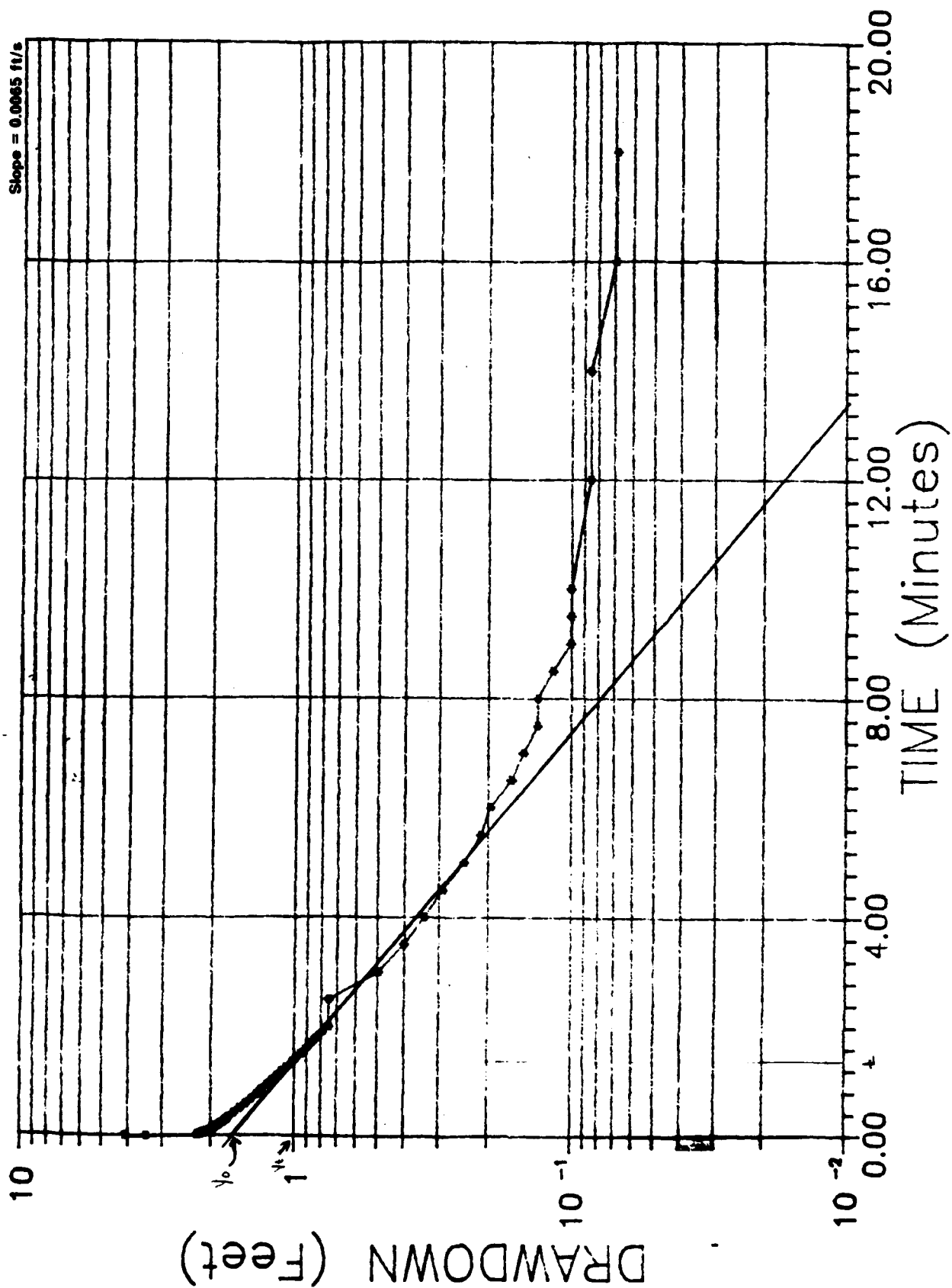
S17-8



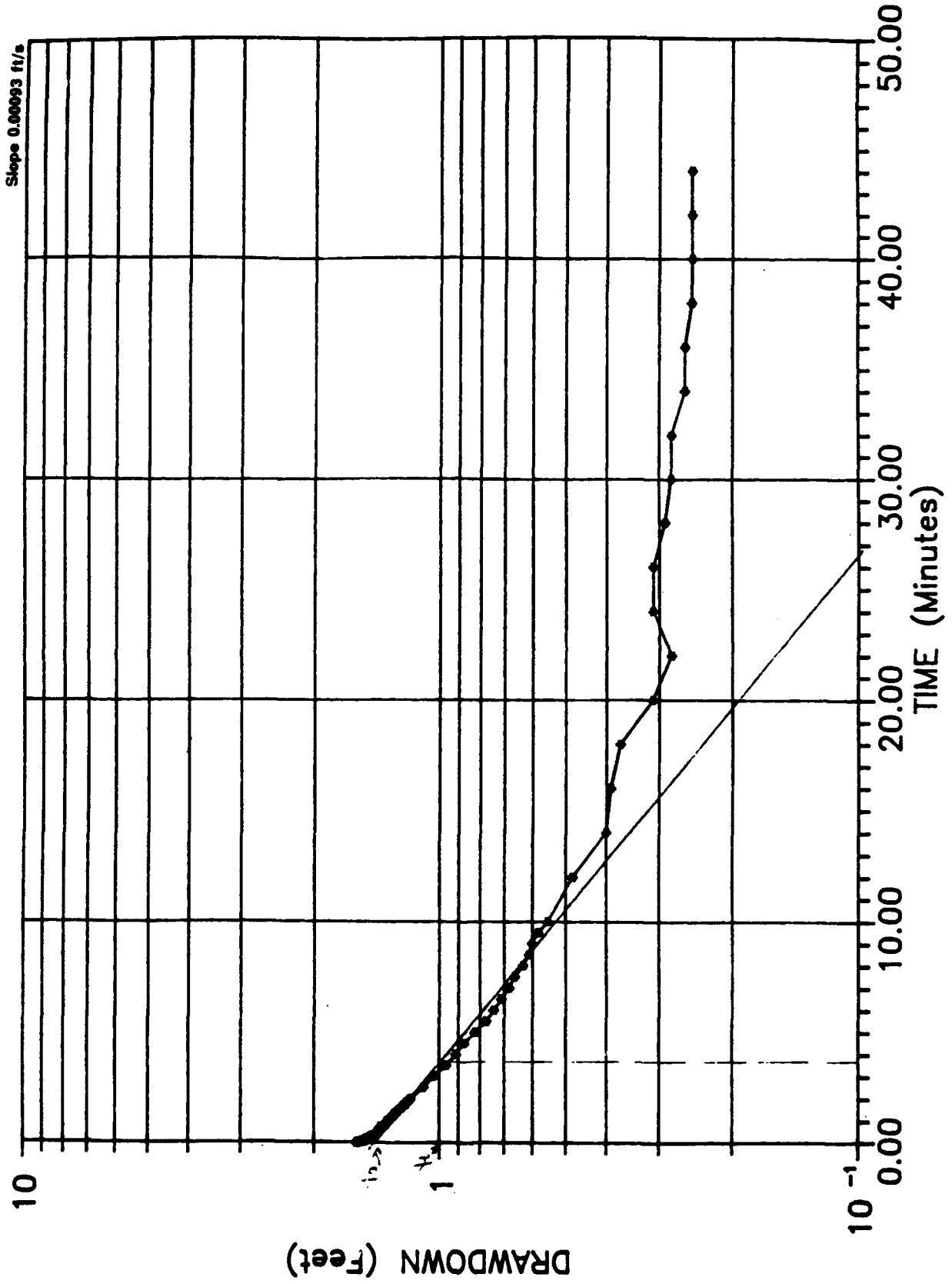
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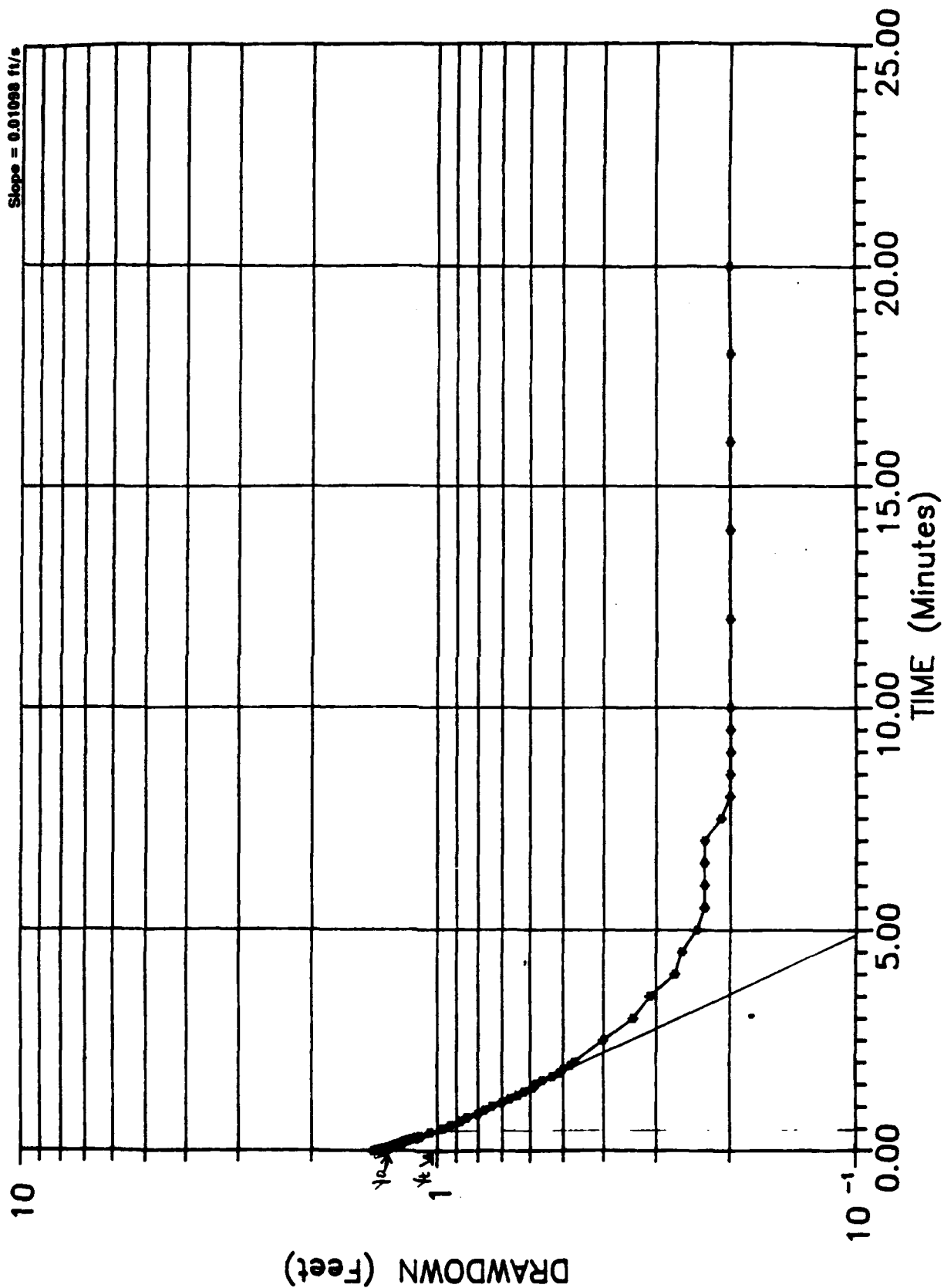
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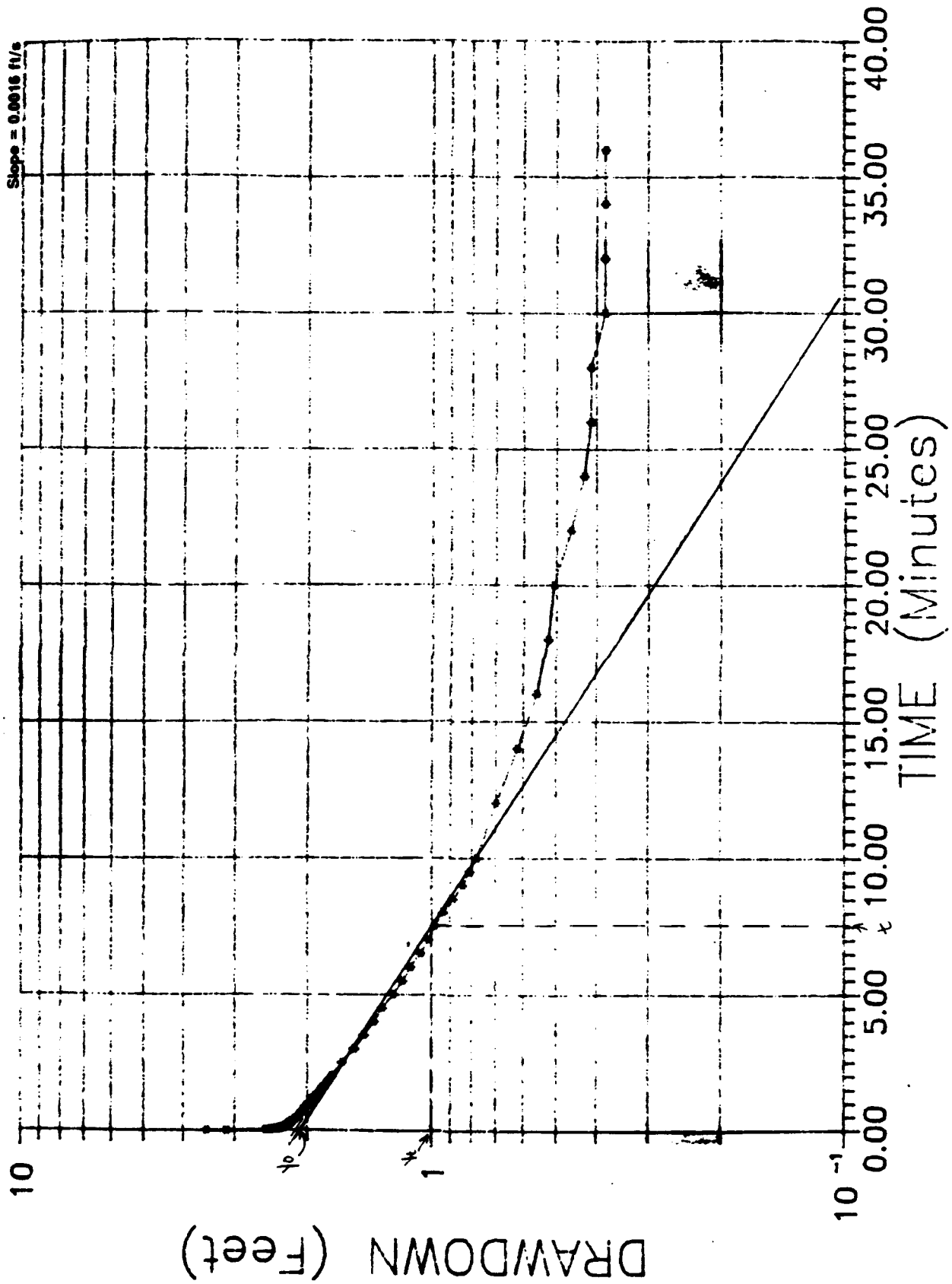
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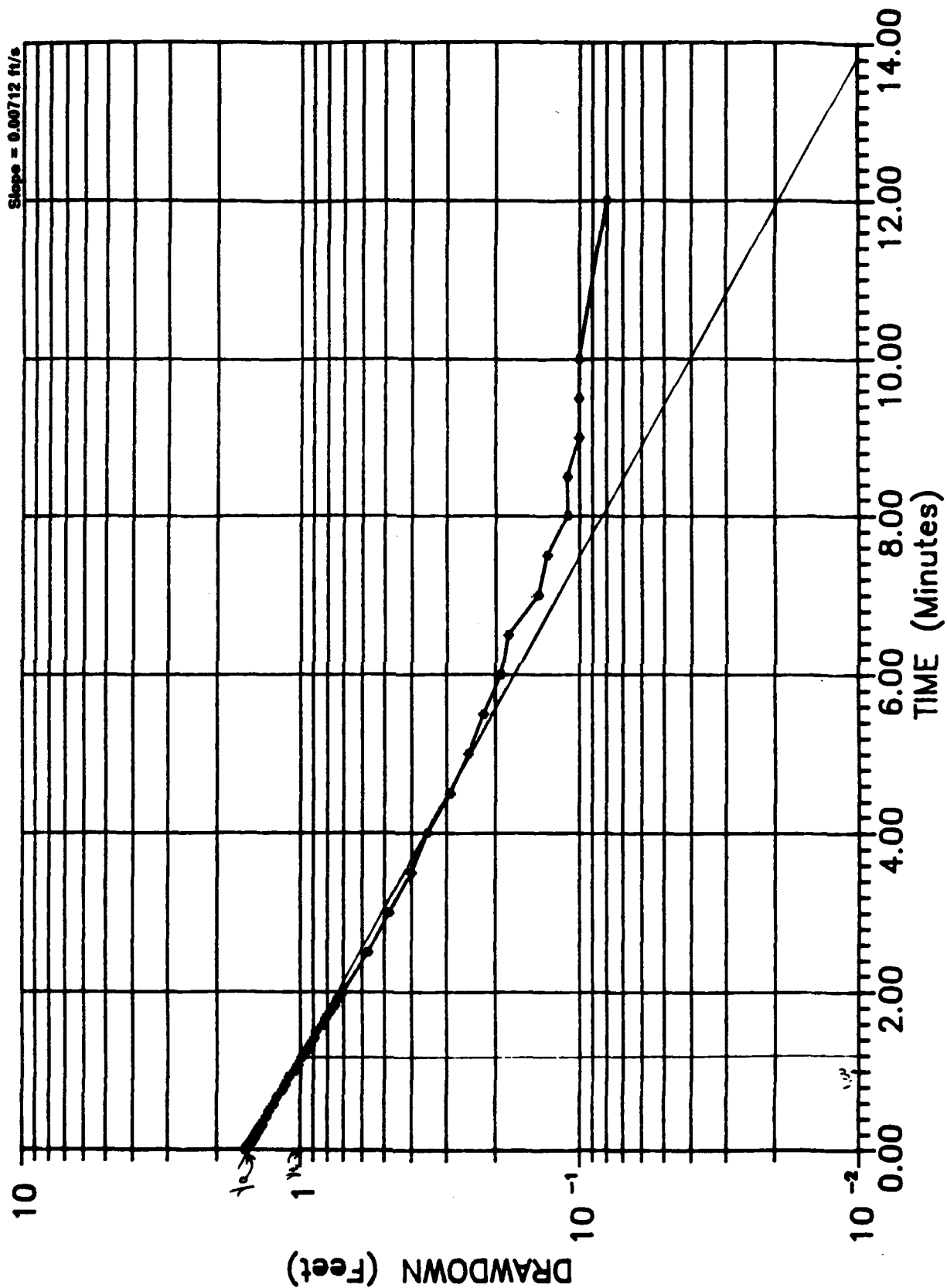
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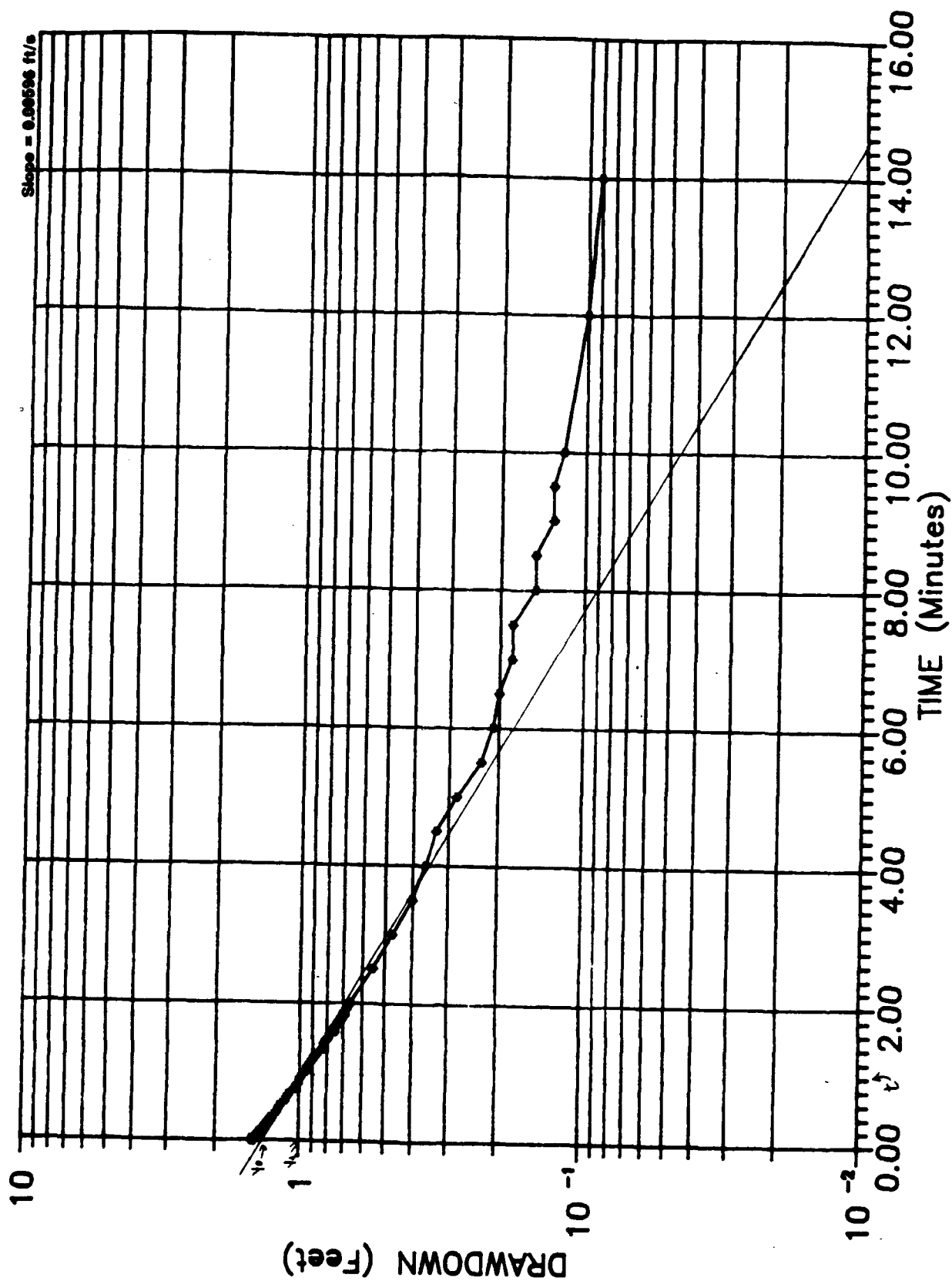
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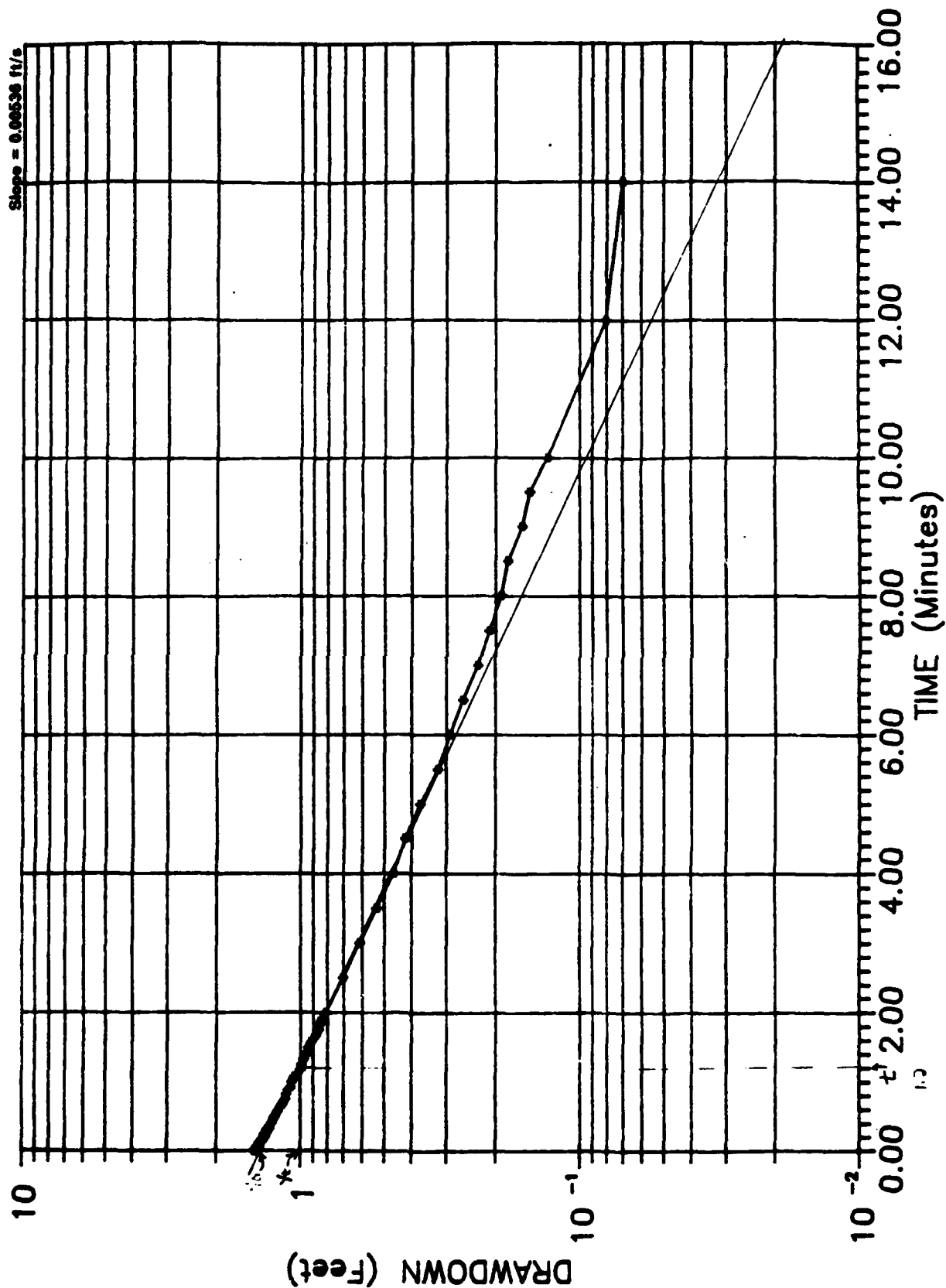
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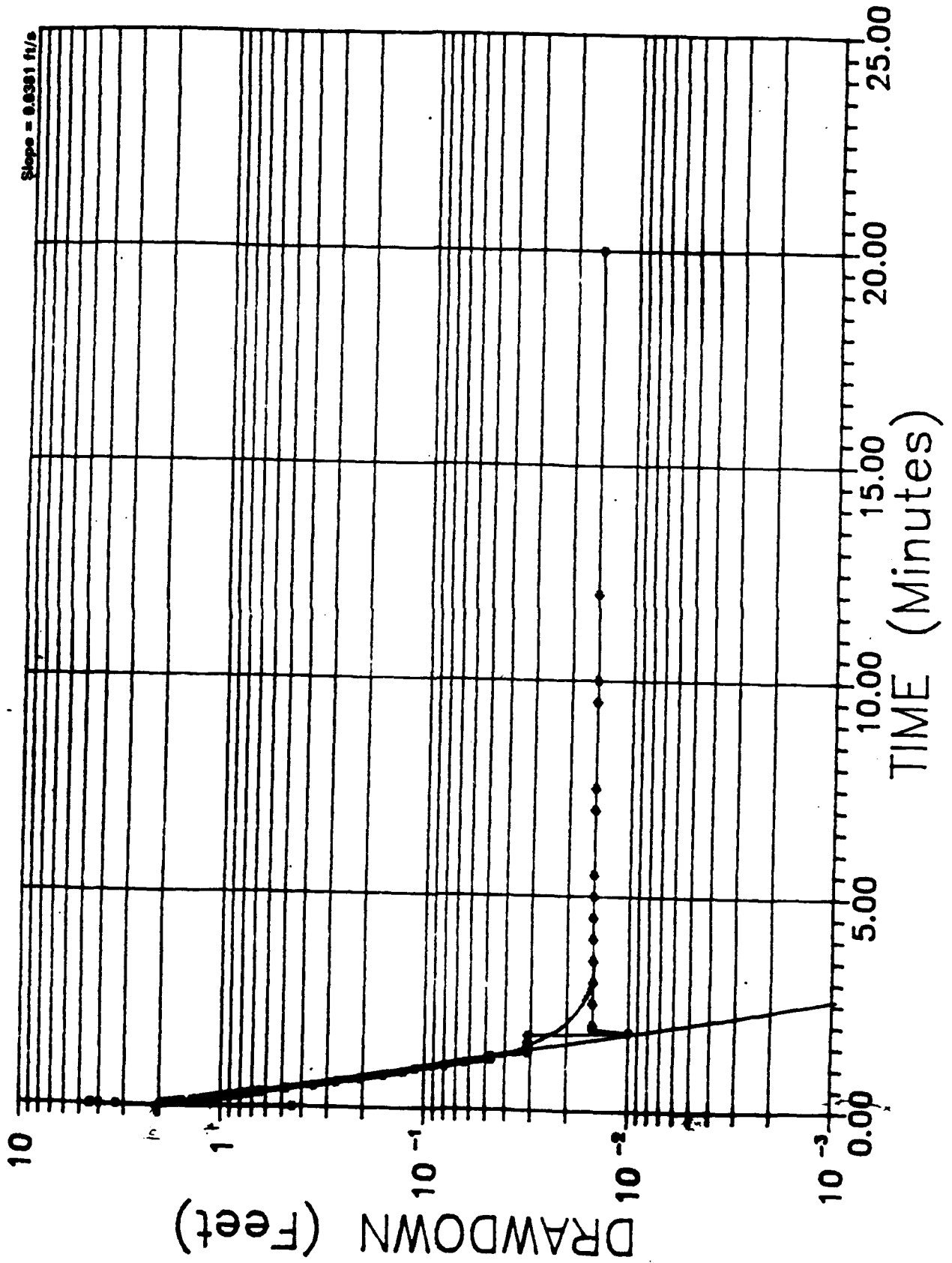
S18-5



S18-6



S18-7



ALLUVIAL SILTY CLAY

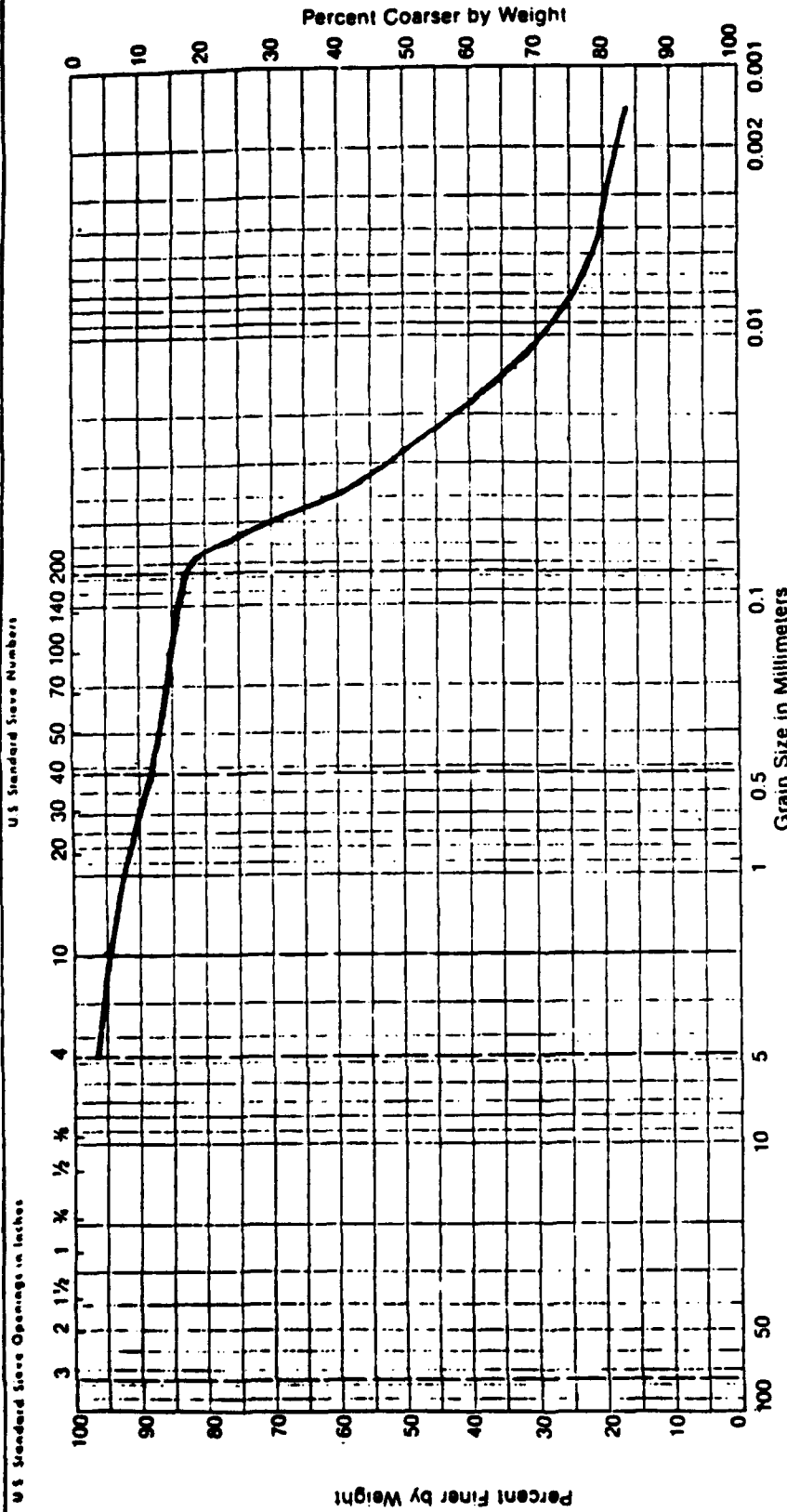
Job No. A-1061
Date Jan. - Feb., 1983

Project: Lake City Army Ammunition Plant SUMMARY OF SOIL TESTS
Independence, Missouri

Boring No.	Sample No.	Depth or Elevation	W %	Dry Unit Weight pcf	Atterberg Limits			Grain Size %			Symbol From Plastic Chart	Unconfined Compression		Swell		Permeability cm/sec.
					LL	PL	PI	Sand	Silt	Clay		tsf	% E	Pres. pcf	% Vol. Increase	
MW 1-6	ST-1	4.5 - 6.0	26.6	98.1	46	20	26	2	72	27	CL					7.64×10^{-9} cm/sec.
MW 1-7	ST-1	9.5 - 11.0	24.5	101.7	51	20	31	0	63	37	CH					2.28×10^{-9} cm/sec.
MW 1-8	ST-2	19.5 - 21.0	31.1	90.6	33	22	11	0	78	22	CL					2.01×10^{-7} cm/sec.
MW 1-9	ST-1	9.5 - 11.0	25.4	101.8	41	20	21	0	59	41	CL					9.6×10^{-9} cm/sec.
MW 1-10	ST-1	15.0 - 16.5	27.8	97.4	39	20	19	2	76	22	CL					6.9×10^{-8} cm/sec.
MW 2-5	ST-1	9.5 - 11.0	27.8	97.2	33	23	10	3	84	13	CL					5.33×10^{-8} cm/sec.
MW 2-6	ST-1	14.5 - 16.0	27.9	98.3	40	21	19	3	69	28	CL					4.14×10^{-8} cm/sec.
MW 2-7	ST-1	10.0 - 11.5	27.7	97.7	41	21	20	2	70	28	CL					3.11×10^{-9} cm/sec.
MW 6-7	ST-2	15.0 - 16.5	27.2	97.6	71	20	51	0	72	28	CH					7.41×10^{-10} cm/sec.
MW 10-5	ST-1	24.5 - 26.0	22.4	105.5	37	23	14	17	65	18	CL					1.61×10^{-7} cm/sec.

• GROUP INFORMATION COMPANY

GRAIN SIZE ANALYSIS



D-58

UNIFIED	AASHTO	GRAVEL		COARSE SAND	MEDIUM SAND	FINE SAND	FINES	
		GRAVEL		COARSE SAND	COARSE SAND	FINE SAND	SILT	CLAY

Boring No.	Sample No.	Sample Depth	LL	W	PL	Classification
MM 10-5	ST-1	24.5-26	37		23	CL

Project: Lake City Army Ammunition Plant

Date Tested: 1/28/83

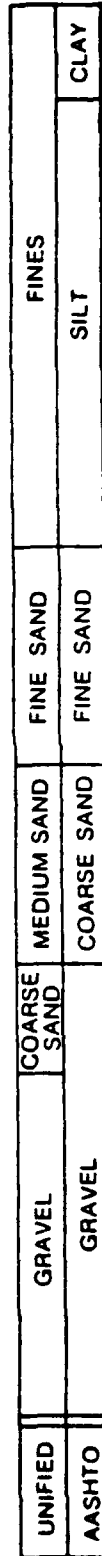
Percent Coarser by Weight

Grain Size in Millimeters

Grain Size (mm)	Percent Coarser (%)
0.001	75
0.002	70
0.005	60
0.01	55
0.02	50
0.05	45
0.1	40
0.2	35
0.5	32
1	30
2	28
5	25
10	22
20	20
50	18
100	15

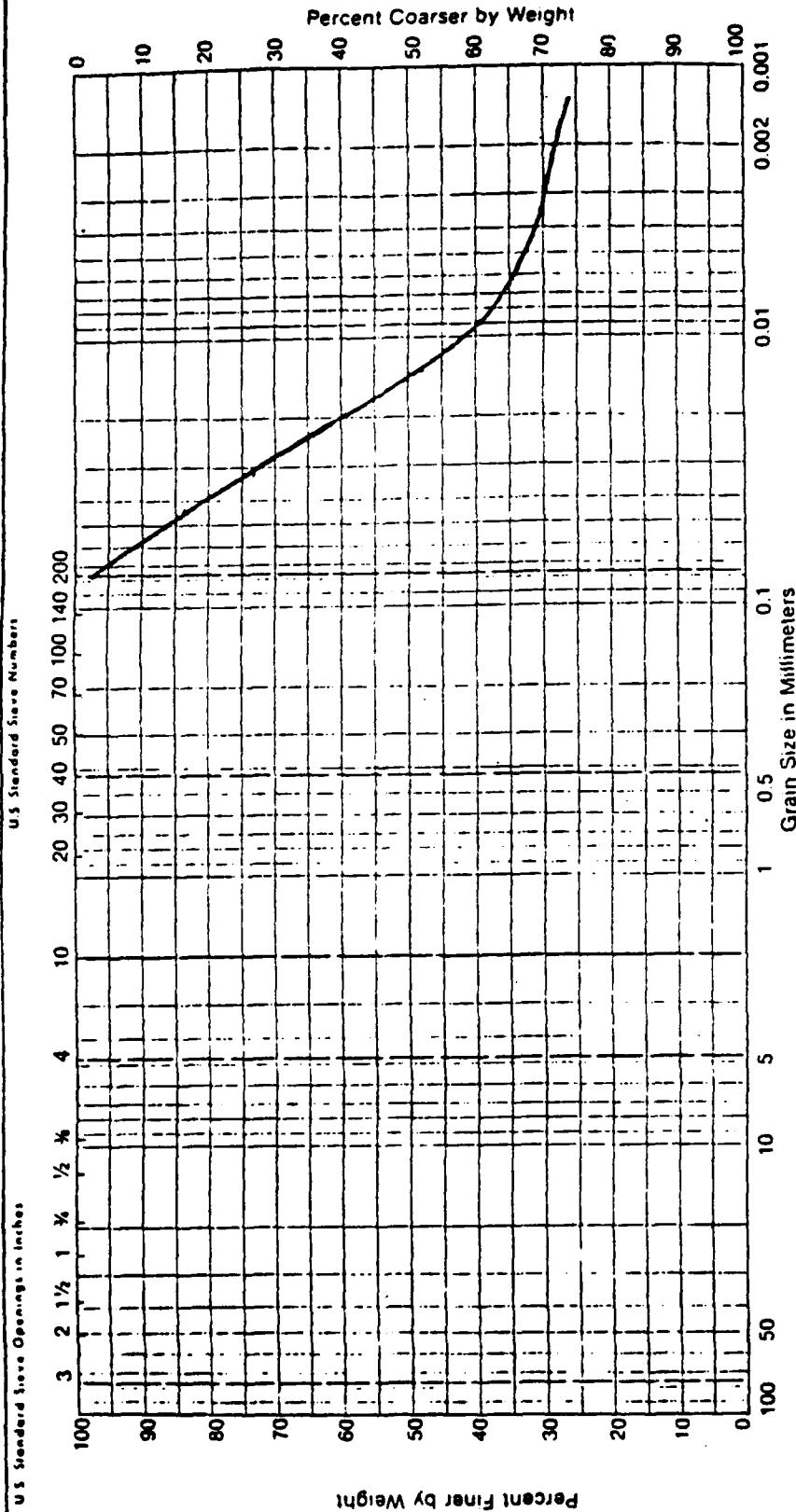
- LAYNE WESTERN COMPANY, INC. -

D-60

[illegible]

- LAYNE WESTERN COMPANY, INC. -

GRAIN SIZE ANALYSIS



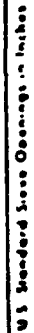
UNIFIED	AASHTO	GRAVEL		COARSE SAND		MEDIUM SAND		FINE SAND		FINES	
		GRAVEL		COARSE SAND		MEDIUM SAND		FINE SAND		SILT	
											CLAY

Boring No.	Sample No.	Sample Depth	LL	W	PL	Classification
MM 2-6	ST-1	14.5-16	40		21	CL

Project: Lake City Army Ammunition Plant

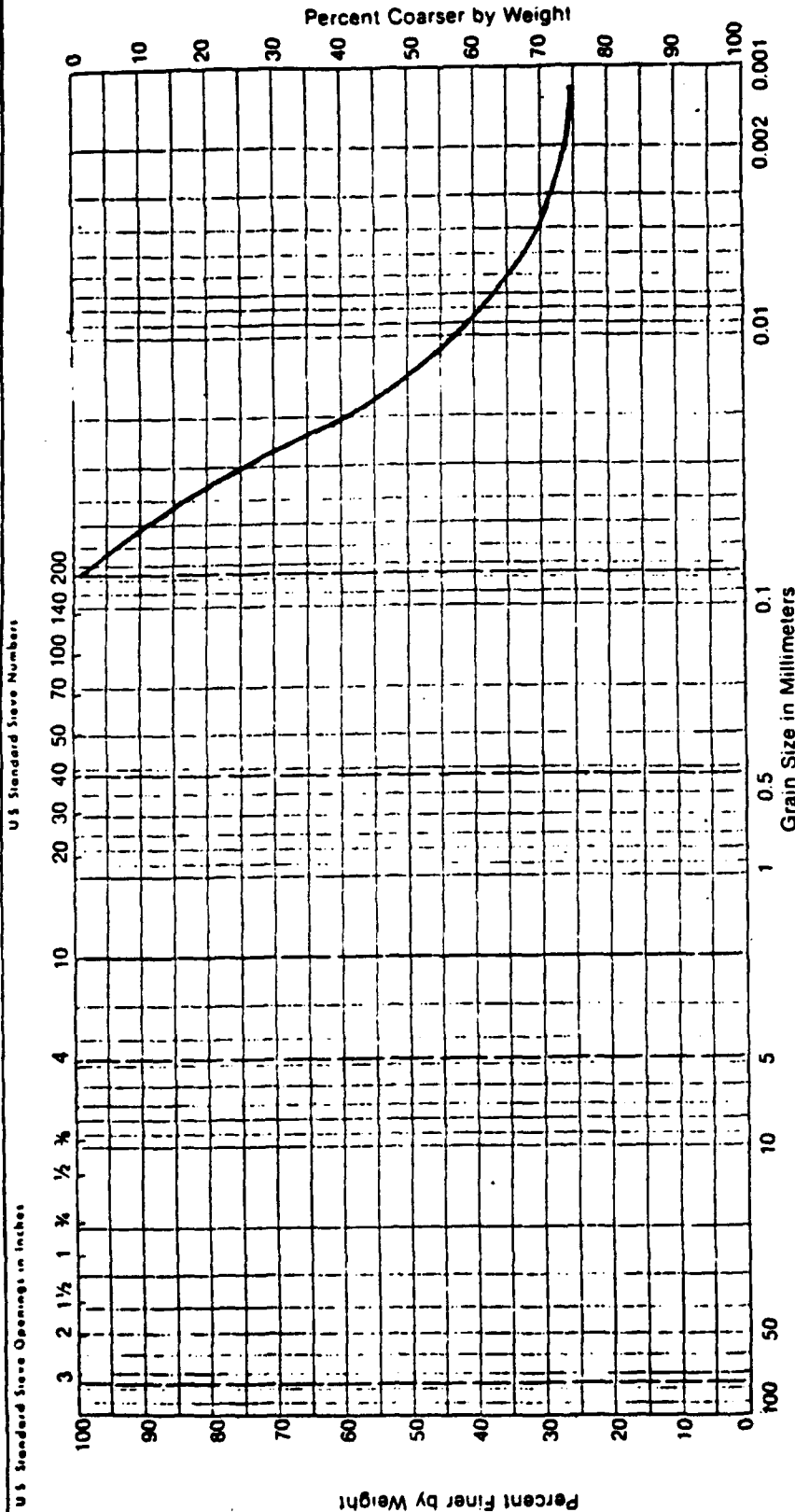
Date Tested: 1/28/83

US Standard Stone Numbers

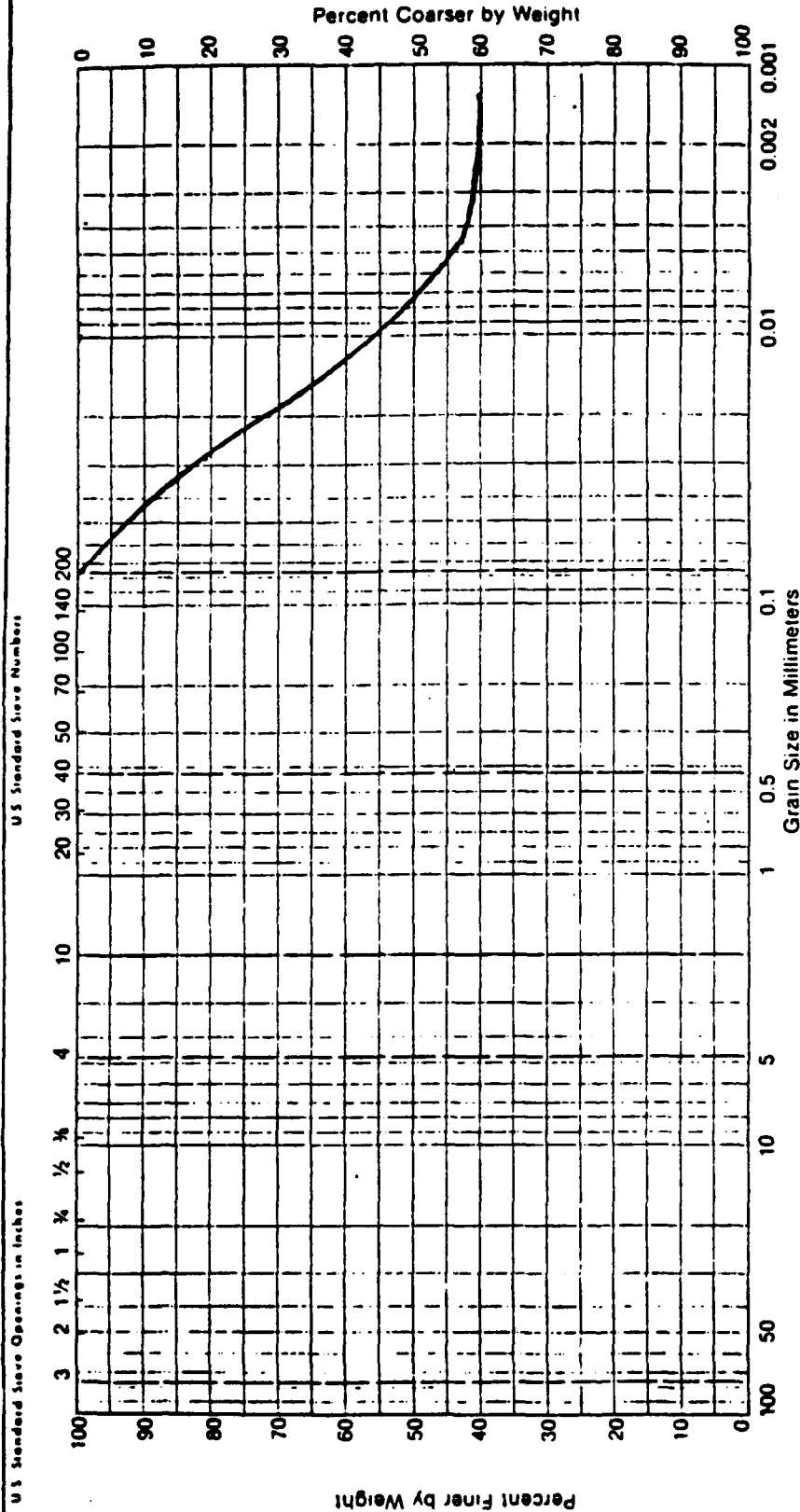


LAYNE WESTERN COMPANY, INC.

GRAIN SIZE ANALYSIS



GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES
AASHTO	GRAVEL	COARSE SAND	COARSE SAND	FINE SAND	SILT CLAY

Boring No.	Sample No.	Sample Depth	LL	W	PL	Classification
MW 1-9	ST-1	9.5-11	41		20	CL

Project: Lake City Army Ammunition Plant

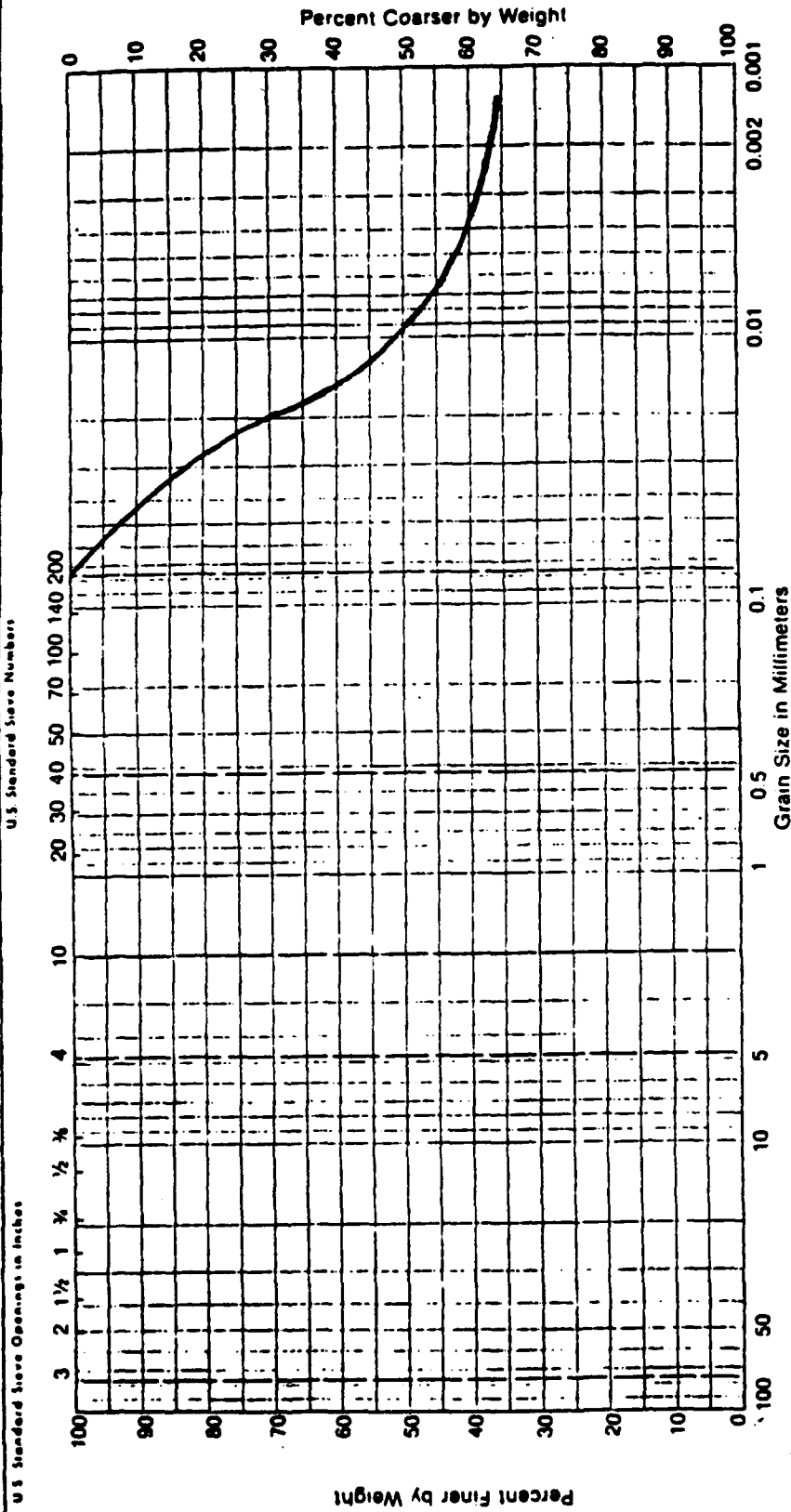
Date Tested: 1/28/83

D-65

[illegible]

- LAYNE WESTERN COMPANY, INC.

GRAIN SIZE ANALYSIS



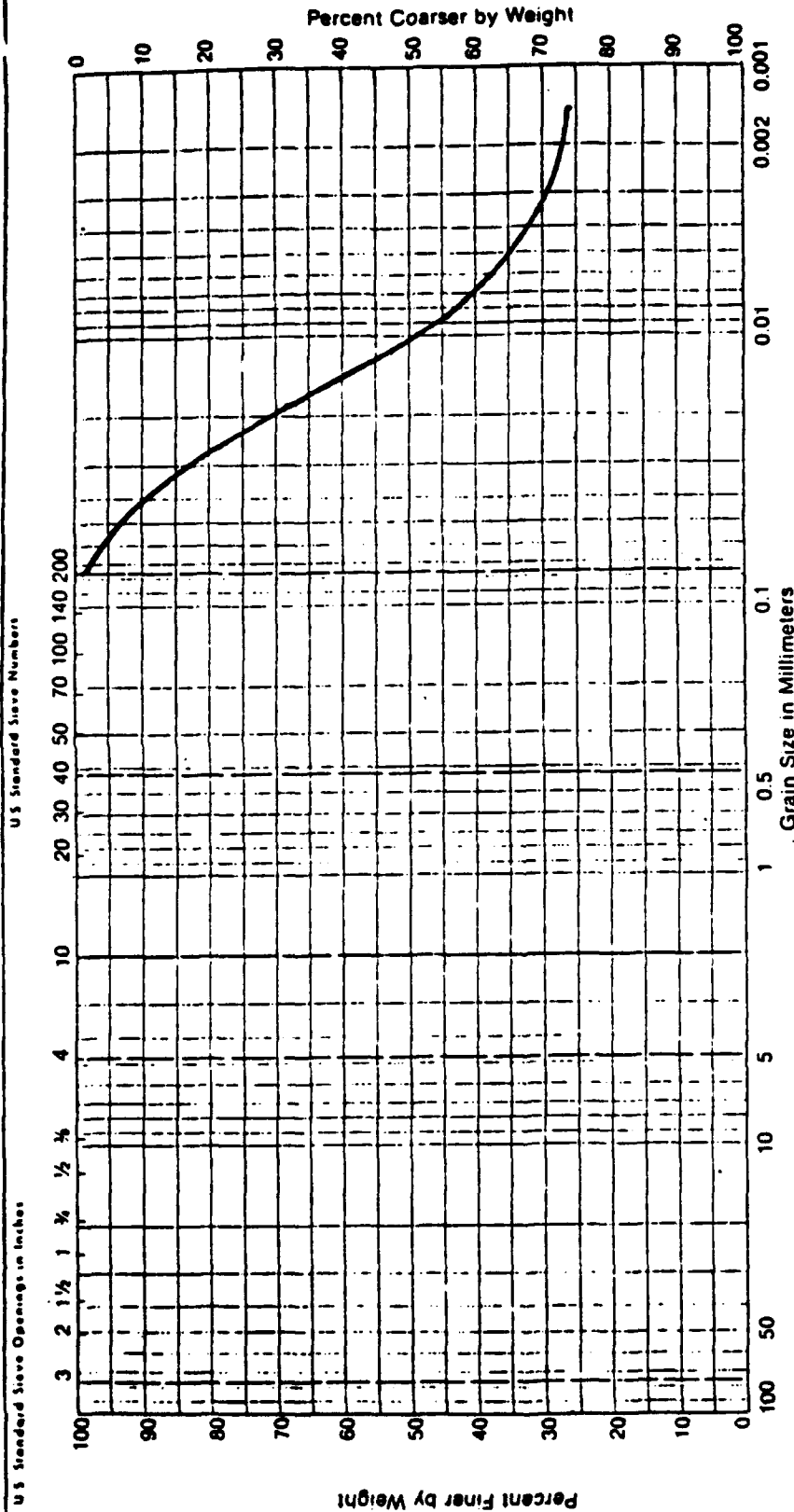
UNIFIED	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES	
AASHTO	GRAVEL		COARSE SAND	FINE SAND	SILT	CLAY

Boring No.	Sample No.	Sample Depth	LL	w	PL	Classification
MW 1-7	ST-1	9.5-11	51		20	CH

Project: Lake City Army Ammunition Plant

Date Tested: 1/28/83

GRAIN SIZE ANALYSIS



PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 2-7 Sample No: ST1 Depth: 10.0-11.5'

Description: Gray brown silty clay w/iron & dark stains & nodules,
firm

Moisture Content: 27.7

Wet Unit Weight: 124.7

Dry Unit Weight: 97.7

Permeability Coefficient for this sample: 3.11×10^{-9} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 2-6 Sample No: ST1 Depth: 14.5-16.0'

Description: Gray brown silty clay w/iron stains, firm

Moisture Content: 27.9

Wet Unit Weight: 125.7

Dry Unit Weight: 98.3

Permeability Coefficient for this sample: 4.14×10^{-8} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 2-5 Sample No: ST1 Depth: 9.5-11.0'

Description: Gray brown silty clay w/iron stains, firm

Moisture Content: 27.8

Wet Unit Weight: 124.2

Dry Unit Weight: 97.2

Permeability Coefficient for this sample: 5.23×10^{-8} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW2-1 Sample No: ST1 Depth: 10-11.5'

Description: Very stiff, gray brown silty clay, with iron
stains and nodules.

Moisture Content: 25.0

Wet Unit Weight: 125.1

Dry Unit Weight: 100.1

Permeability Coefficient for this sample: 3.62×10^{-8} cm./sec.

This permeability coefficient indicates a nearly impermeable material.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 1-10 Sample No: ST1 Depth: 15.0-16.5'

Description: Gray brown silty clay w/iron & dark nodules, firm

Moisture Content: 27.8

Wet Unit Weight: 124.5

Dry Unit Weight: 97.4

Permeability Coefficient for this sample: 6.06×10^{-8} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 1-9 Sample No: ST1 Depth: 9.5-11.0'

Description: Gray brown silty clay w/iron nodules & stains, firm

Moisture Content: 25.4

Wet Unit Weight: 127.7

Dry Unit Weight: 101.8

Permeability Coefficient for this sample: 9.60×10^{-9} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 1-8 Sample No: ST2 Depth: 19.5-21.0'

Description: Brown w/trace gray silty clay w/iron stains, firm

Moisture Content: 31.1

Wet Unit Weight: 118.7

Dry Unit Weight: 90.6

Permeability Coefficient for this sample: 2.01×10^{-7} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 1-7 Sample No: ST1 Depth: 9.5-11.0'

Description: Gray brown silty clay w/trace gravel, iron nodules
& stains, very stiff

Moisture Content: 24.5

Wet Unit Weight: 126.6

Dry Unit Weight: 101.7

Permeability Coefficient for this sample: 2.78×10^{-9} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 1-6 Sample No: ST1 Depth: 4.5-6.0'

Description: Gray brown silty clay, iron stain & nodules, firm

Moisture Content: 26.6

Wet Unit Weight: 124.3

Dry Unit Weight: 98.1

Permeability Coefficient for this sample: 7.64×10^{-9} cm/sec.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 10-5 Sample No: ST1 Depth: 24.5-26.0'

Description: Olive brown shaly clay, very stiff

Moisture Content: 22.4

Wet Unit Weight: 129.1

Dry Unit Weight: 105.5

Permeability Coefficient for this sample: 1.61×10^{-7} cm/sec.

ALLUVIAL SAND

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 9-3 Sample No: Bag #1 Depth: 33'-44'

Description: Gray fine to medium sand with trace of silt.

Moisture Content: _____

Wet Unit Weight: _____

Dry Unit Weight: _____

Permeability Coefficient for this sample: 1.1×10^{-2} cm/sec.

This permeability coefficient for this sample indicates a medium degree of permeability.

PERMEABILITY TEST

Job Name: Lake City Army Ammunition Plant

Well No: MW 9-2 Sample No: Bag #1 Depth: 32.5'-40.0'

Description: Gray silty fine to medium sand

Moisture Content: _____

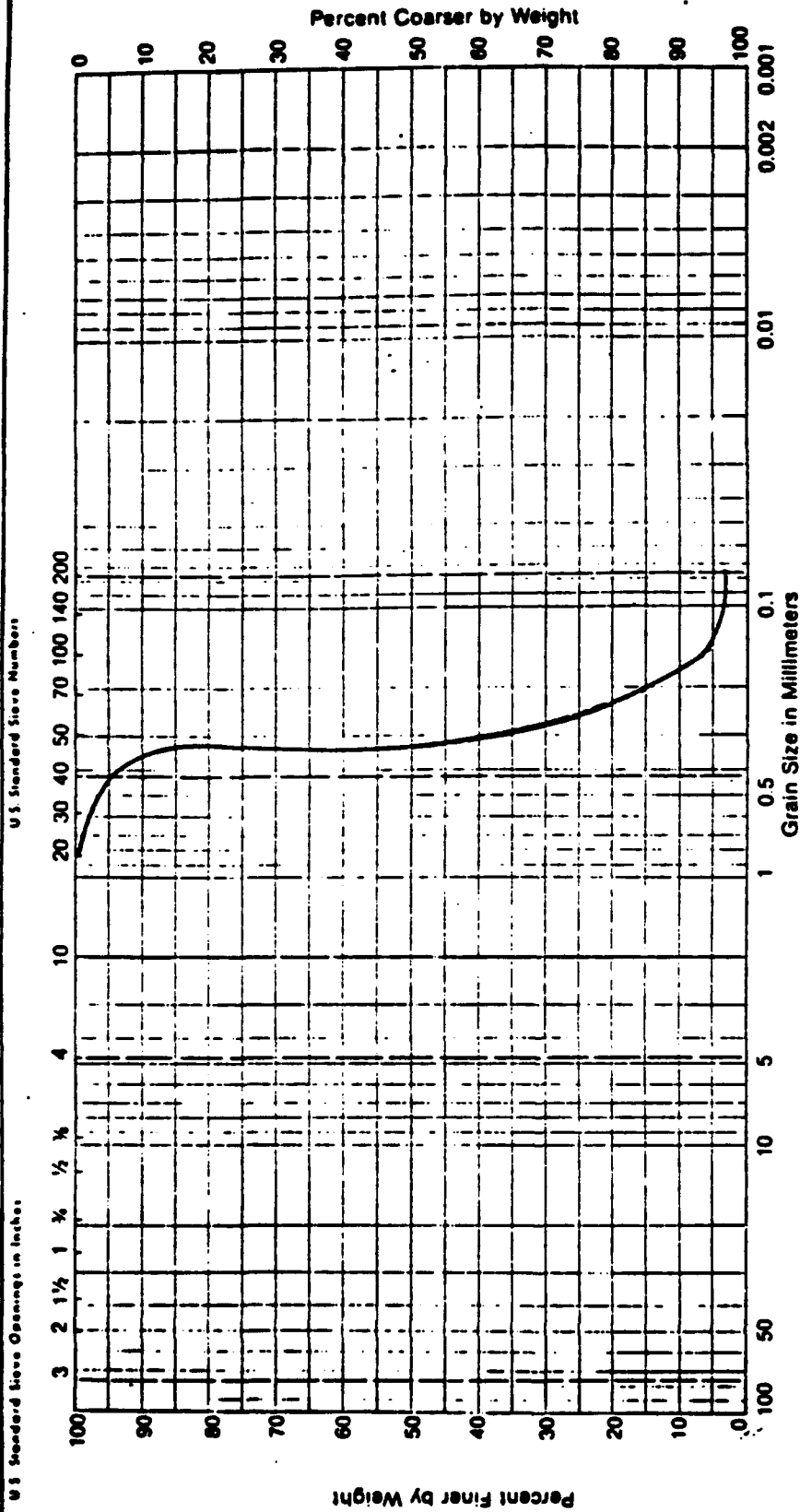
Wet Unit Weight: _____

Dry Unit Weight: _____

Permeability Coefficient for this sample: 9.0×10^{-3} cm/sec.

This permeability coefficient indicates a medium degree of permeability for this sample.

GRAIN SIZE ANALYSIS



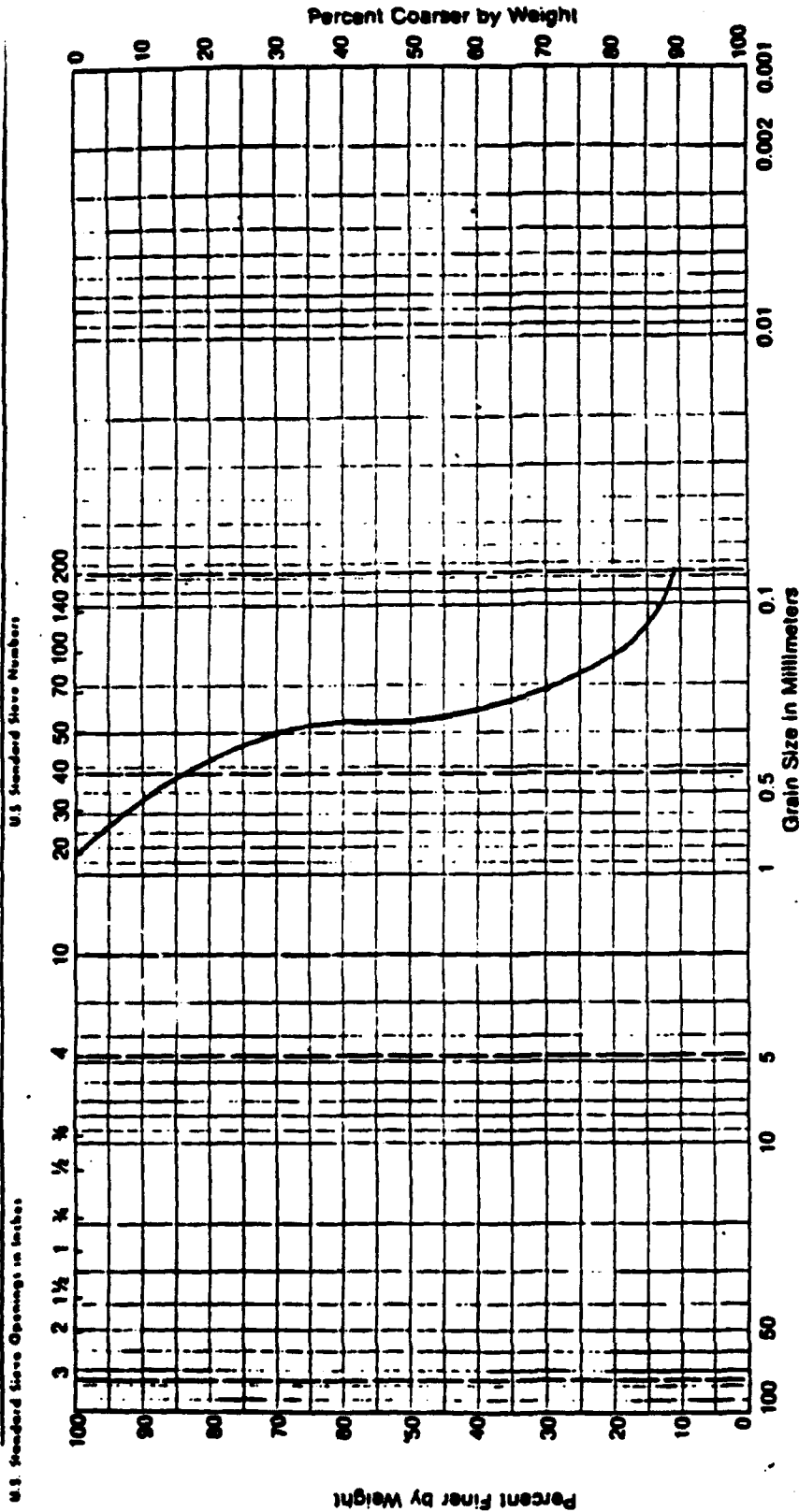
UNIFIED	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES
AASHTO	GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY

Boring No.	Sample No.	Sample Depth	LL	W	PL	Classification
NW 7-3A	BAG	34-37'				2 1/2 - 100%
						5 1/2 - 100% sand
						4 1/2 - 100% sand
						2 1/2 - 100% sand
						2 1/2 - 100% sand

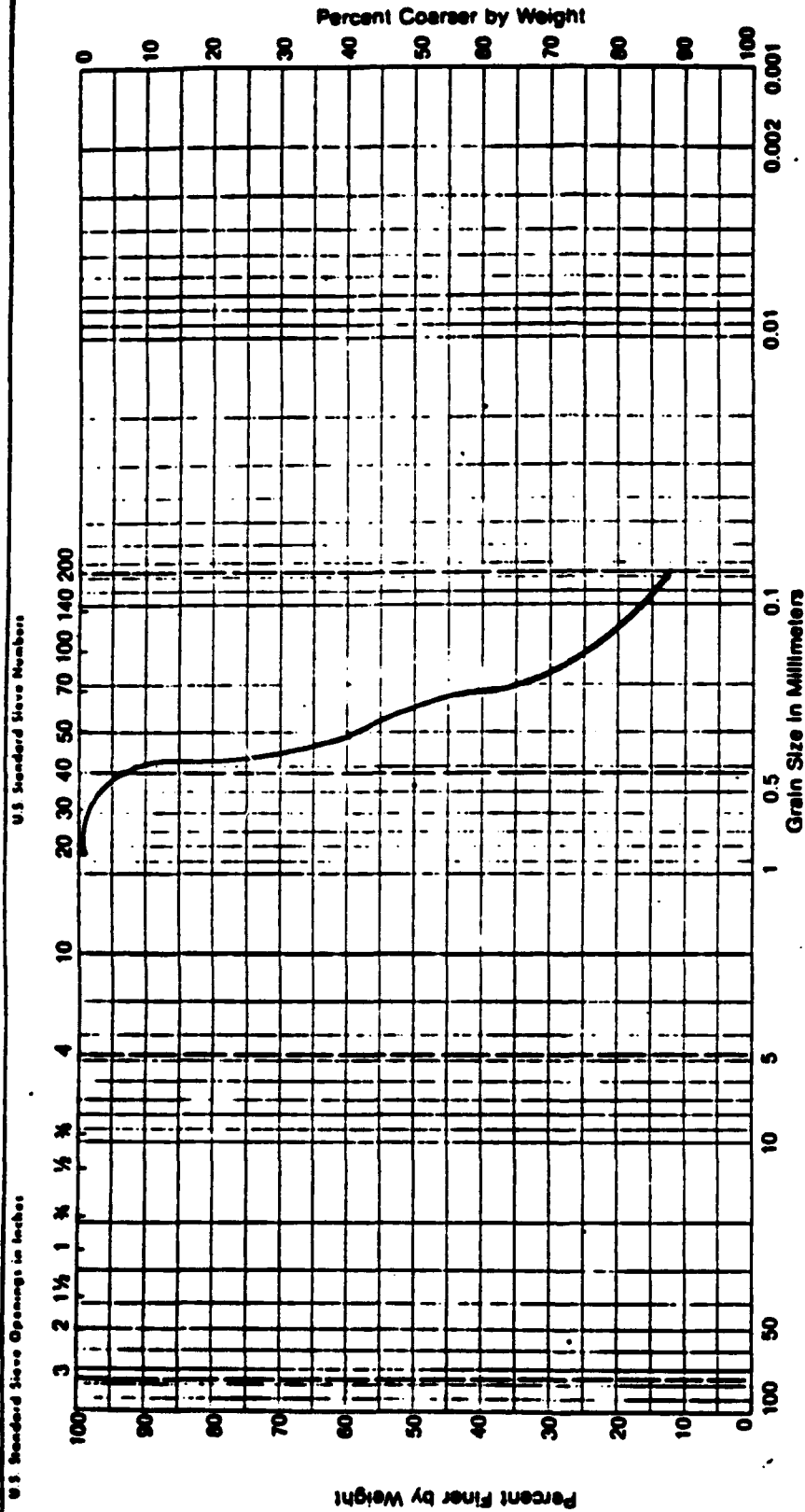
Project: Lake City AAP
Independence, Missouri

Date Tested: 9-16-81

GRAIN SIZE ANALYSIS



GRAIN SIZE ANALYSIS

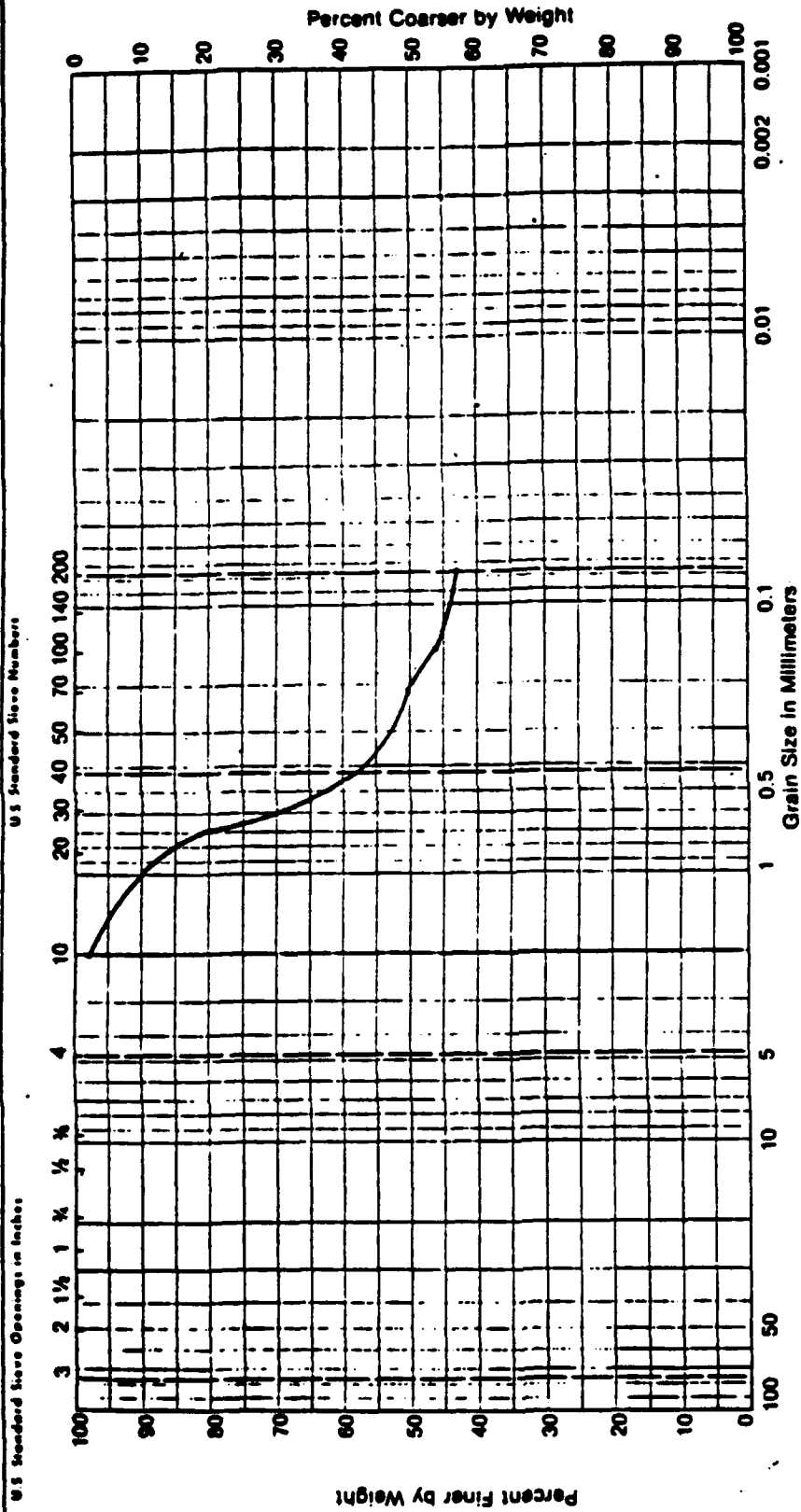


UNIFIED	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES
AASHTO	GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY

Soil No.	Sample No.	Sample Depth	LL	W	PL	Classification	Project:
3-3	ST1	9.5-11'				10% gravel 17% m.s.c. sand 90% fine sand 1% silt and clay	Lake City AAP Independence, Missouri
							Date tested: 9-14-81

LAYNE WESTERN COMPANY, INC.

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES	
AASHTO	GRAVEL		COARSE SAND	FINE SAND	SILT	CLAY

Booring No.	Sample No.	Sample Depth	LL	w	PL	Classification
3-1	SS2	19.5-21"				3 1/2 glaucl.
						- 9 1/2 bl. - c. sil. s.
						14 20 ft. in sand.
						4 1/2 ft. silty clay

Project: Lake City AAP
Independence, Missouri
 Date Tested: 9-14-81

LAYNE WESTERN COMPANY, INC.-

PRODUCTION WELL PUMP RATE DATA

SHEET 1 of 2CLIENT/SUBJECT Air Force / Pump Test Data Reduction W.O. NO. 2285-05-10TASK DESCRIPTION Backcalculation to est. individual pump rates. TASK NO. 0030PREPARED BY R. Groat DEPT 1535 DATE 9/23/88

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY

DEPT _____ DATE _____

Designation	Pump	Calculated Q (gpm)
A	17AA	483
B	17BB	350
C	17CC	*
D	17DD	433
E	17E	*
F	17EE	358
G	17FF	150
H	17GG	*
I	—	—
J	17J	*
K	17JJ	442
L	17K	267
M	17KK	292

* Not used between 5/1/88 and 5/16/88
— Pump no in.



SHEET 2 of 2

CLIENT/SUBJECT Air Force / Pump Test Data Reduction W.O. NO. 2285-05-10
 TASK DESCRIPTION Back calc. to estimate individual pumping rates TASK NO. 0030
 PREPARED BY R. Gnat DEPT 1535 DATE 9/23/88
 MATH CHECK BY _____ DEPT _____ DATE _____
 METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY

DEPT _____ DATE _____

$$\begin{aligned} B + D + F + G + M &= 95,000 \text{ g/hr} = 1583 \text{ gpm} \\ B + D + F + M &= 86,000 \text{ g/hr} = 1433 \text{ gpm} \end{aligned} \quad \therefore Q_G = 150 \text{ gpm}$$

$$\begin{aligned} B + D + F + M &= 86,000 \text{ g/hr} = 1433 \text{ gpm} \\ B + F + M &= 60,000 \text{ g/hr} = 1000 \text{ gpm} \end{aligned} \quad \therefore Q_D = 433 \text{ gpm}$$

$$\begin{aligned} A + B + k + L &= 92,500 \text{ g/hr} = 1542 \text{ gpm} \\ A + B + F + k + L &= 114,000 \text{ g/hr} = 1900 \text{ gpm} \end{aligned} \quad \therefore Q_F = 358 \text{ gpm}$$

$$\begin{aligned} B + D + F + M &= 83,000 \text{ g/hr} = 1383 \text{ gpm} \\ B + D + k + M &= 88,000 \text{ g/hr} = 1467 \text{ gpm} \\ \therefore K = F + 84 &= 358 + 84 = 442 \end{aligned} \quad \therefore Q_K = 442 \text{ gpm}$$

$$\begin{aligned} A + D + G + k &= 90,500 \text{ g/hr} = 1508 \text{ gpm} \\ \therefore A = 1541 - D - G - k &= 433 \end{aligned} \quad \therefore Q_A = 433 \text{ gpm}$$

$$\begin{aligned} A + B + D + G + k &= 111,500 \text{ g/hr} = 1858 \text{ gpm} \\ \therefore B = 1858 - 1508 &= 350 \end{aligned} \quad \therefore Q_B = 350 \text{ gpm}$$

$$\begin{aligned} M &= 1433 - B - D - F = 292 \\ L &= 1542 - A - B - k = 267 \end{aligned} \quad \begin{aligned} \therefore Q_M &= 292 \text{ gpm} \\ \therefore Q_L &= 267 \text{ gpm} \end{aligned}$$

●

GENERAL LOG NO 1

WATER DEPT.

BUDG. NO. 16

DATE 5-1-88

SPARKING										P M			CHEM. ANALYSIS						LINE 19			ALUM 2			Clear				
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
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W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
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W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain			Grain			Grain			Grain	
W										Gr. Pump			Filter Inflow			P P M			Grain</										

Jockey off at 7:30 am
P. on P. Highway

12/19/91

14:19

88-0

003

CLC 05

GENERAL LOG NO 1

WATER DEPT.

BLDG. NO. 16

DATE 5-2-88

WELLS										SPARKING		P M		CHEM. ANALYSIS				LINE		DATE		ALUM		6		
HOURS RUN										Motor	Cal. Pump	P	MO	ON	WCS	CO	H	P.P.M.	Days	1924	2535	1029	3	3	117	
1	2	3	4	5	6	7	8	9	10																	
1	2	3	4	5	6	7	8	9	10	250060	127	10.0	10.0	9.5	20.34	6	0	90	96	2250	245	11.8	1060	31	6.7	6.3
11	12	13	14	15	16	17	18	19	20	250136	176	8.9	9.1	9.5	11.36	0	0	36	91	3013	273	10.9	1104	44	1.8	6.6
21	22	23	24	25	26	27	28	29	30	250436	200	9.7	9.7	9.5	16.32	0	0	32	94	3321	308	10.8	1153	49	1.7	6.5
31	32	33	34	35	36	37	38	39	40	250678	242	9.7	9.5	9.5	12.3	0	0	17	11	3714	393	11.4	1209	56	1.6	6.4
41	42	43	44	45	46	47	48	49	50	250844	166	9.6	9.5	9.4	12.34	0	0	24	94	3544	285	12.0	1200	40	1.7	8.0
51	52	53	54	55	56	57	58	59	60	251012	163	9.6	9.1	9.5	12.32	0	0	24	92	4289	286	11.9	1296	47	1.9	9.0
61	62	63	64	65	66	67	68	69	70	251219	204	9.6	9.7	9.5	12.32	0	0	17	94	4637	346	11.7	1336	50	1.7	11.0
71	72	73	74	75	76	77	78	79	80	251299	30									4769	138	12.0	1369	53	1.5	4.7
81	82	83	84	85	86	87	88	89	90	251366	176									1326						
91	92	93	94	95	96	97	98	99	100																	

DEC 19 '91 14:30

PAGE 1.003

GENERAL LOG NO 1															WATER DEPT.										BLDG. NO. 16										DATE 5-3-88																																																																																																													
WELLS															SPARKING										PH										CHEM. ANALYSIS										LIME										ALUM																																																																																									
HOURS RUN															M										GAL										P.M.										P.M.										P.M.										P.M.																																																																															
															Name										P										M										C										M										M										M																																																																					
															251299										190										98										94										2										32										54										50										72																																																	
															251624										185										97										95										14										39										0										10										58										94										53										66																			
															251668										184										96										95										14										36										0										8										22										76										36										78																			
															252056										208										96										95										12										36										0										12										24										41										60										54																			
															252279										183										95										95										11										12										36										0										12										34										94										23										43									
															252359										180										93										93										10										34										0										14										23										43										66										26																			
															252602										143										94										93										93										10										34										0										14										23										94										55										52									
															252677										145										94										93										93										10										34										0										14										23										94										70										17									
															252711										145										94										93										93										10										34										0										14										23										94										70										17									
															252745										145										94										93										93										10										34										0										14										23										94										70										17									
															252779										145										94										93										93										10										34										0										14										23										94										70										17									
															252813										145										94										93										93										10										34										0										14										23										94										70										17									
															252847										145										94										93										93										10										34										0										14										23										94										70										17									
															252881										145										94										93										93										10										34										0										14										23										94										70										17									
															252915										145										94										93										93										10										34										0										14										23										94										70										17									
															252949										145										94										93										93										10										34										0										14										23										94										70										17									
															252983										145										94										93										93										10										34										0										14										23										94										70										17									
															253017										145										94										93										93										10										34										0										14										23										94										70										17									
															253051										145										94										93										93										10										34										0										14										23										94										70										17									
															253085										145										94										93										93										10										34										0										14										23										94										70										17									
															253119										145										94										93										93										10										34										0										14										23										94										70										17									
															253153										145										94										93										93										10										34										0										14										23										94																													

WELLS										SPARKLING		PH		CHEM. ANALYSIS				LIME		ALUM		Clear Water ft.				
HOURS RUN										In Gal. Pump	In Gal. Pump	pH	Filtered Sediment				Range	LIME	ALUM	Clear Water ft.						
1	2	3	4	5	6	7	8	9	10				P.P.M.								Range	LIME	ALUM	Clear Water ft.		
										P	NO	NO	CO	IN												
1	2	3	4	5	6	7	8	9	10	Mean																
1	2	3	4	5	6	7	8	9	10	254248	171	9.1	8.2	8.8	8.94	0	26	16	110	9556	289	11.8	210.8	41	1.7	6.5
1	2	3	4	5	6	7	8	9	10	254422	174	9.3	9.4	8.7	9.2	0	18	24	102	5845	289	11.6	214.9	41	1.6	6.0
1	2	3	4	5	6	7	8	9	10	254641	219	7.1	9.4	8.7	9.2	0	16	24	98	355	355	11.3	220.1	52	1.7	6.7
1	2	3	4	5	6	7	8	9	10	254831	190	9.1	9.4	8.8	9.1	0	14	20	94	527	327	12.0	224.9	48	1.8	7.2
1	2	3	4	5	6	7	8	9	10	255010	175	9.5	9.4	8.5	9.0	0	14	20	94	850	293	11.5	229.4	45	1.7	8.6
1	2	3	4	5	6	7	8	9	10	255180	170	9.5	9.4	8.5	9.0	0	16	20	96	1107	287	11.8	233.8	44	1.8	7.3
1	2	3	4	5	6	7	8	9	10	255350	176	9.5	9.4	8.5	9.0	0	16	20	96	1404	297	11.8	238.3	45	1.8	7.9
1	2	3	4	5	6	7	8	9	10	255504	88									1553	144	11.8	240.6	53	1.8	11.6
TOTAL										1367									2286			339				

12/19/91

14:22

007

G.C. 0211

GENERAL LOG NO 1

WATER DEPT.

BLDG. NO. 16

DATE 5-6-81

WELLS												SPARKING				PH		CHEM. ANALYSIS				LIME		ALUM		Other Mg Ca				
HOURS RUN												M Gd. Pump	Infl. Pilot	Infl. Pilot	Filter Influent				Mg Ca H	Mg Ca H	Mg Ca H	Mg Ca H								
1	2	3	4	5	6	7	8	9	10	11	12				P	NO	ON	NO					CO	H	P	NO	ON	NO	CO	H
255444												168	9.1	9.1	14	30	0	2	21	90	1835	287	118	2449	43	18	71			
255779												167	9.1	9.1	16	32	0	2	20	84	2103	268	112	2132	43	18	71			
255947												168	9.7	9.7	16	32	0	0	32	86	2372	268	112	2535	43	18	71			
256114												167	9.7	9.7	12	30	0	1	24	78	2640	268	112	2578	43	18	71			
256381												167	9.9	9.9	11	30	0	0	32	84	2908	268	112	2651	43	18	71			
256449												165	9.7	9.7	12	32	0	5	24	72	3177	269	112	2664	43	18	71			
256610												161	9.8	9.7	14	30	0	2	28	72	3436	259	113	2705	41	18	71			
256712												162									3611	175	110	2730	25	12	113			
2568																														
TOTAL																														
Min																														
Max																														
Avg																														

Removal of

22

5

GENERAL LOG NO. 1

WATER DEPT.

BLDG. NO. 16

DATE 1/5/51

16-D

[illegible]

171	171
172	172

[illegible]

12/19/91

14:26

005

START PUMP TEST
(11:00)
DATE 5-10-88

BLDG. NO. 16

WATER DEPT.

GENERAL LOG NO 1

WELLS										SPARKING		PH		CHEM. ANALYSIS				LINE		ALUM		CL		
SOUNDING DATA										WELL	No.	Pump	Inches	Feet	P.P.M.				Page	No.	Feet	No.	Feet	No.
1	2	3	4	5	6	7	8	9	10						11	12	13	14						
11:00	1	1	1	1	1	1	1	1	1	259134										7	4	3	3851	167
11:05	1	1	1	1	1	1	1	1	1															
11:10	1	1	1	1	1	1	1	1	1															
11:15	1	1	1	1	1	1	1	1	1															
11:20	1	1	1	1	1	1	1	1	1															
11:25	1	1	1	1	1	1	1	1	1															
11:30	1	1	1	1	1	1	1	1	1															
11:35	1	1	1	1	1	1	1	1	1															
11:40	1	1	1	1	1	1	1	1	1															
11:45	1	1	1	1	1	1	1	1	1															
11:50	1	1	1	1	1	1	1	1	1															
11:55	1	1	1	1	1	1	1	1	1															
12:00	1	1	1	1	1	1	1	1	1															
12:05	1	1	1	1	1	1	1	1	1															
12:10	1	1	1	1	1	1	1	1	1															
12:15	1	1	1	1	1	1	1	1	1															
12:20	1	1	1	1	1	1	1	1	1															
12:25	1	1	1	1	1	1	1	1	1															
12:30	1	1	1	1	1	1	1	1	1															
12:35	1	1	1	1	1	1	1	1	1															
12:40	1	1	1	1	1	1	1	1	1															
12:45	1	1	1	1	1	1	1	1	1															
12:50	1	1	1	1	1	1	1	1	1															
12:55	1	1	1	1	1	1	1	1	1															
13:00	1	1	1	1	1	1	1	1	1															
13:05	1	1	1	1	1	1	1	1	1															
13:10	1	1	1	1	1	1	1	1	1															
13:15	1	1	1	1	1	1	1	1	1															
13:20	1	1	1	1	1	1	1	1	1															
13:25	1	1	1	1	1	1	1	1	1															
13:30	1	1	1	1	1	1	1	1	1															
13:35	1	1	1	1	1	1	1	1	1															
13:40	1	1	1	1	1	1	1	1	1															
13:45	1	1	1	1	1	1	1	1	1															
13:50	1	1	1	1	1	1	1	1	1															
13:55	1	1	1	1	1	1	1	1	1															
14:00	1	1	1	1	1	1	1	1	1															
14:05	1	1	1	1	1	1	1	1	1															
14:10	1	1	1	1	1	1	1	1	1															
14:15	1	1	1	1	1	1	1	1	1															
14:20	1	1	1	1	1	1	1	1	1															
14:25	1	1	1	1	1	1	1	1	1															
14:30	1	1	1	1	1	1	1	1	1															
14:35	1	1	1	1	1	1	1	1	1															
14:40	1	1	1	1	1	1	1	1	1															
14:45	1	1	1	1	1	1	1	1	1															
14:50	1	1	1	1	1	1	1	1	1															
14:55	1	1	1	1	1	1	1	1	1															
15:00	1	1	1	1	1	1	1	1	1															
15:05	1	1	1	1	1	1	1	1	1															
15:10	1	1	1	1	1	1	1	1	1															
15:15	1	1	1	1	1	1	1	1	1															
15:20	1	1	1	1	1	1	1	1	1															
15:25	1	1	1	1	1	1	1	1	1															
15:30	1	1	1	1	1	1	1	1	1															
15:35	1	1	1	1	1	1	1	1	1															
15:40	1	1	1	1	1	1	1	1	1															
15:45	1	1	1	1	1	1	1	1	1															
15:50	1	1	1	1	1	1	1	1	1															
15:55	1	1	1	1	1	1	1	1	1															
16:00	1	1	1	1	1	1	1	1	1															
16:05	1	1	1	1	1	1	1	1	1															
16:10	1	1	1	1	1	1	1	1	1															
16:15	1	1	1	1	1	1	1	1	1															
16:20	1	1	1	1	1	1	1	1	1															
16:25	1	1	1	1	1	1	1	1	1															
16:30	1	1	1	1	1	1	1	1	1															
16:35	1	1	1	1	1	1	1	1	1															
16:40	1	1	1	1	1	1	1	1	1															
16:45	1	1	1	1	1	1	1	1	1															
16:50	1	1	1	1	1	1	1	1	1															
16:55	1	1	1	1	1	1	1	1	1															
17:00	1	1	1	1	1	1	1	1	1															
17:05	1	1	1	1	1	1	1	1	1															
17:10	1	1	1	1	1	1	1	1	1															
17:15	1	1	1	1	1	1	1	1	1															
17:20	1	1	1	1	1	1	1	1	1															
17:25	1	1	1	1	1	1	1	1	1															
17:30	1	1	1	1	1	1	1	1	1															
17:35	1	1	1	1	1	1	1	1	1															
17:40	1	1	1	1	1	1	1	1	1															
17:45	1	1	1	1	1	1	1	1	1															
17:50	1	1	1	1	1	1	1	1	1															

88-11-2
1531 8004

GENERAL LOG NO 1 WATER DEPT. B.L.C. NO. 14

88-11-88

[illegible]

1933 FINISHED RAMP TEST
1934 FINISHED RECORD
DATE 5-13-78

91DC. NO. 16

WATER DEPT.

GENERAL LOG NO. 1

[illegible]

90

GENERAL LOG NO. 1

WATER DEPT.

BLDC. NO. 16

4521, 190023

DATE 5-14-88

[illegible]

CLC 405

STOPPED ACCIDENT TEST
07:40

GENERAL LOG NO 1

DATE 5-15-68

[illegible]

Jockey pump off
Jockey pump on 5:00pm

APPENDIX E

**EQUATIONS USED FOR ANALYSIS OF
PUMPING TEST DATA**

Barometric Efficiency (BE)

$$BE = \frac{wdh}{dP_a} \quad \text{where}$$

w = unit weight of water
dh = change in head
dP_a = change in atmospheric pressure

Relationship of Aquifer Storage (S) to BE

$$S = \frac{n\beta\rho_w g}{BE} \quad \text{where,}$$

n = porosity
β = aquifer compressibility
ρ_w = density of water
g = gravitational constant

Equations for calculating aquifer characteristics for a leaky system with release from storage from the aquitard layer and partially penetrating wells (Hantush, 1964; Walton 1979).

$$s = \frac{Q}{4\pi T} W(u, T) + W\left(\frac{r}{m} \sqrt{P_v/P_h}, l', d', y'\right) \quad \text{where,}$$

s = drawdown (ft).
T = transmissivity
Q = discharge
W(u, T) = well function for a leaky confined aquifer
W(r/m √P_v/P_h) = well function correction for a leaky confined aquifer with partially penetrating wells having no storage capacity and long pumping periods.
r = radial distance from the pumping well to the observation well (ft.)
m = aquifer thickness
P_v = vertical permeability of aquifer
P_h = horizontal permeability of aquifer
l', d', y' = define geometry of production well and observation wells relative.
s = $\frac{Tt}{1.87 r^2}$ where,
u = dimensionless parameter of the well function exponential defined through curve matching.
t = time (days)
T = transmissivity (gpd/ft)

APPENDIX F
STATISTICAL BACKGROUND VALUES

Calculation of statistical significance of individual parameter data with average background data using Cochran's Approximation to the Behrens-Fisher students' t-test as adapted from 40CFR Part 264, Appendix IV.

Calculate the mean (\bar{X}_B) and variance (S^2_B) for background data.

For the monitoring date, the analytical result constitutes the value (V_m), and its variance (S^2_m) will be zero.

This data is used to calculate a t-statistic (t^*), and a comparison t-statistic (t_c).

The value of t^* is calculated as follows:

$$t^* = \frac{V_m - \bar{X}_B}{\sqrt{(S^2_B/N_B) + (S^2_m/N_m)}}$$

If the value of t^* is negative ($\bar{X}_B > V_m$), then there can be no significant increase, since the background is greater than the monitoring point.

If the value of t^* is positive ($V_m > \bar{X}_B$) then the t_c value must be calculated for comparison:

$$t_c = \frac{(S^2_B/N_B)(t_B) + (S^2_m/N_m)(t_m)}{(S^2_B/N_B) + (S^2_m/N_m)}$$

Since the monitoring value variance (S_m^2) is zero, the formula reduces to:

$$t_c = \frac{(S^2_B/N_B)(t_B)}{(S^2_B/N_B)} = t_B$$

If the value of t^* is equal to or larger than t_c , then there most likely has been a significant increase for the parameter.

If the value of t^* is less than t_c , then there most likely has not been a significant increase for the parameter.

The use of zero variance for the monitoring value is rather conservative, since no allowance for analytical variability is considered.

However, this conservative approach may be justified under these circumstances.

Solve for the value V_m where $t^* = t_c$.

If a discrete monitoring value is $\geq V_m$ then there most likely has been a significant increase above background for the parameter.

If a discrete monitoring value is $< V_m$ then there most likely has not been a significant increase above background for the parameter.

$$t^* = \frac{V_m - \bar{X}_B}{\sqrt{\frac{S_B^2}{N_B} + \frac{S_m^2}{N_m}}} = \frac{V_m - \bar{X}_B}{\sqrt{\frac{S_B^2}{N_B}}} = \frac{V_m - \bar{X}_B}{\frac{S_B}{\sqrt{N_B}}}$$

$$V_m = t^* \left(\frac{S_B}{\sqrt{N_B}} \right) + \bar{X}_B = \bar{X}_B + t_B \frac{S_B}{\sqrt{N_B}} \quad \text{where } \bar{X}_B = \text{Background mean}$$

t_B = From T-Table
one tail at
 $N_B - 1$ degrees of
Freedom (df)

Example: Background DATA

10 units
15 units
20 units
25 units

$$N_B = 4$$

$$\bar{X}_B = 17.5$$

$$S_B = 5.59$$

$$\alpha = .05 \text{ (95\% confidence - one tail)}$$

$$F = 4 - 1 = 3$$

$$t_B = 2.353$$

Monitoring DATA Significant Above Background

20	—	NO
18	—	NO
30	—	YES
35	—	YES
10	—	NO
40	—	YES
25	—	YES

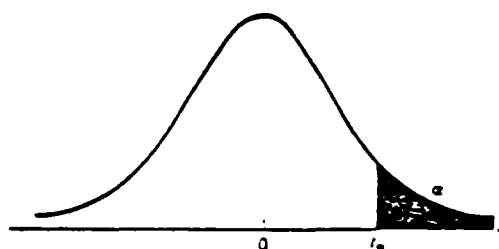
S_B = Background standard deviation

N_B = Number of background samples

$$V_m = 17.5 + 2.353 \left(\frac{5.59}{\sqrt{4}} \right) = 24.08$$

F-2

Therefore All monitoring data shown above that is $\geq V_m$ falls outside the 95% confidence level & is

TABLE E Student *t* Distribution

The following table provides the values of t_α that correspond to a given upper-tail area α and a specified number of degrees of freedom.

Degrees of Freedom	Upper-Tail Area α									
	.4	.25	.1	.05	.025	.01	.005	.0025	.001	.0005
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657	127.32	318.31	636.62
2	.259	.316	1.886	2.920	4.303	6.965	9.925	14.089	22.327	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	7.453	10.214	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	4.773	5.993	6.859
6	.265	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.731
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.537
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.423	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

SOURCE: E.S. Pearson and H.O. Hartley, *Biometrika Tables for Statisticians*, Vol. I. London: Cambridge University Press, 1966. Partly derived from Table III of Fisher and Yates, *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver & Boyd, Edinburgh, 1963). Reproduced with permission of the authors and publishers.

BACKGROUND GROUNDWATER		Well 1-4		Well 1-5		Well 4-6		Well 8-6		Well 11-3		Well 17-1		X _B	S _B	V _m		
		Round 1	Round 2	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Log			Anti- Log		
Antimony	dis	ND	ND	ND	ND	0.67	ND	ND	ND	ND	ND	ND	ND	0.18	0.23	0.15	0.32	2.07
	tot	ND	ND	ND	ND	1.06	ND	ND	ND	ND	ND	ND	ND	0.18	0.27	0.26	0.42	2.64
Arsenic	dis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.40	—	—	—	2.51
	tot	ND	ND	ND	ND	ND	0.71	0.88	ND	ND	ND	ND	ND	0.40	0.56	0.27	0.72	5.21
Barium	dis		2.05	2.51		2.12		2.14				2.37		1.10	2.25	0.17	2.41	2.58
	tot		2.13	3.17		2.19		2.60				2.56		1.10	2.52	0.39	2.89	780.
Beryllium	dis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05	—	—	—	0.05
	tot	0.47	-0.30	-0.26	-0.70	-0.70	-0.15	-0.09	-0.22	-0.30	-0.04	-1.30		-0.23	0.32	-0.04	0.90	0.90
Cadmium	dis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.41	—	—	—	2.55
	tot	ND	ND	1.39	ND	1.52	ND	ND	ND	ND	ND	ND	ND	0.41	0.62	0.42	0.86	7.31
Chromium	dis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.27	—	—	—	18.62
	tot	ND	ND	1.69	ND	1.54	ND	ND	ND	ND	ND	ND	ND	1.27	1.34	0.14	1.42	26.38
Copper	dis	ND	ND	ND	0.70	ND	ND	ND	ND	ND	ND	0.56	0.56	-0.05	0.09	0.27	0.25	1.76
	tot	1.85	1.04	2.30	1.11	0.59	1.62	1.48	1.35	1.48	1.12	1.48	1.12	-0.05	1.40	0.45	1.66	45.82

Level
Kalechay

	Well 1-4		Well 1-5		Well 4-6		Well 8-6		Well 11-3		Well 17-1		XB	SB	Vm	
	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2			log	anti-log
Lead	dis	0.50	0.92	ND	ND	ND	ND	ND	ND	0.75	ND	0.10	0.29	0.30	0.46	2.91
	tot	1.76	ND	1.65	0.55	ND	1.36	1.30	ND	1.42	1.57	0.10	0.99	0.66	1.37	23.58
Mercury	dis	-0.70	ND	ND	ND	ND	ND	ND	ND	ND	ND	-1.10	-1.06	0.12	-0.99	0.08
	tot	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-1.10	—	—	—	0.08
Nickel	dis	1.15	ND	ND	1.22	ND	ND	ND	1.28	ND	ND	0.68	0.84	0.25	0.98	9.66
	tot	1.90	ND	2.54	1.16	0.99	1.48	1.68	1.5	1.71	1.45	0.68	1.51	0.49	1.79	62.23
Selenium	dis	0.87	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.40	—	—	—	2.51
	tot	ND	0.75	ND	ND	ND	ND	ND	ND	ND	ND	0.40	0.43	0.10	0.48	3.79
Silver	dis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-1.05	—	—	—	0.09
	tot	ND	-0.68	-0.28	ND	ND	ND	-0.49	ND	ND	ND	-1.05	-0.88	0.27	-0.72	0.19
Zinc	dis	2.65	1.52	1.32	2.43	1.48	2.71	1.26	2.96	ND	2.90	0.93	2.02	0.74	2.45	281.
	tot	2.87	1.79	3.04	3.04	2.85	2.77	2.36	2.99	2.34	2.98	0.93	2.70	0.39	2.93	844.

BACKGROUND SOILS

	BGS1	BGS2	BGS3	BGS4	\bar{X}	S _B	Vm 109	Vm entilog
Barium	2.28	2.17	2.41	2.31	2.29	0.09	2.40	2.79 ⁴⁴ %
Beryllium	-0.55	-0.55	-0.35	-0.51	-0.49	0.08	-0.41	0.40 ⁴⁴ %
Chromium	1.11	1.12	1.13	1.11	1.12	0.01	1.13	13.49 ⁴⁴ %
Copper	1.05	1.11	1.35	1.18	1.17	0.11	1.30	19.95 ⁴⁴ %
Lead	0.89	0.80	1.17	1.02	0.97	0.14	1.13	13.49 ⁴⁴ %
Nickel	1.35	1.56	1.29	1.31	1.38	0.11	1.51	32.36 ⁴⁴ %
Zinc	1.83	2.10	1.99	1.93	1.96	0.10	2.08	120.2 ⁴⁴ %
Arsenic	0.45	0.45	0.45	0.45	0.45	0.00	0.45	2.82 ⁴⁴ %
Cadmium	-0.46	-0.46	-0.46	-0.46	-0.46	0.00	-0.46	0.35 ⁴⁴ %
Mercury	-1.30	-1.30	-1.30	-1.30	-1.30	0.00	-1.30	0.05 ⁴⁴ %
Antimony	0.10	0.10	0.10	0.10	0.10	0.00	0.10	1.26 ⁴⁴ %
Silver	-0.49	-0.49	-0.49	-0.49	-0.49	0.00	-0.49	0.32 ⁴⁴ %
Selenium	0.02	0.02	0.02	0.02	0.02	0.00	0.02	1.05 ⁴⁴ %

Background Surface Water Inorganics

SW-16

Copper	4.93 ug/l
Nickel	12.00 ug/l
Zinc	404.00 ug/l
all others	ND

(only one background sample was collected)

APPENDIX G
CHEMICAL DATA

The LCAAP Level Three chemical data will be submitted at a later date as a separate addendum to this RI.

A0039

APPENDIX H

TOXICITY SUMMARIES

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TOXICITY SUMMARIES

Antimony

Antimony was detected in the monitoring well within the production well capture zone, Area 1, 2, 4, 5, 8, and 17 groundwater wells, in surface water in the Area 13 drainage ditch, the pond, and Ditch B. and in subsurface soil in Area 15.

Antimony is a metal which occurs both in the trivalent and pentavalent oxidation states (EPA 1980). Absorption of this metal via oral and inhalation routes of exposure is low (EPA 1980). Humans and animals exposed acutely orally or through inhalation to either trivalent or pentavalent forms of antimony displayed electrocardiogram (ECG) changes and myocardial lesions (EPA 1980). Pneumoconiosis has been observed in humans exposed by acute inhalation and dermatitis has occurred in individuals exposed either orally or dermally. Oral administration of therapeutic doses in humans has been associated with nausea, vomiting, and hepatic necrosis (EPA 1980). Chronic exposure by inhalation of antimony has led to respiratory effects including macrophage proliferation and activity, fibrosis and pneumonia in animals (EPA 1980). A single report (Balyeava 1967) noted an increase in spontaneous abortions, premature births, and gynecological problems in 318 female workers exposed to a mixture of antimony metal, antimony trioxide, and antimony pentasulfide dusts.

EPA (1988) derived an oral RfD of 4×10^{-4} mg/kg/day for antimony based on a chronic oral study (Schroeder et al. 1970) in which rats given the metal in drinking water had altered blood glucose and blood cholesterol levels and decreased lifespan. By using an uncertainty factor of 1,000, a LOAEL of 0.35 mg/kg/day was used to derive the oral RfD.

Arsenic

Arsenic was detected in groundwater in the production wells, the monitoring well within the production well capture zone, and Area 1, 2, 3, 4, 5, 6, 7, 8, 16, and 17 wells and in surface water in the pond and Ditch B. It was also detected in sediments in the Area 13 and 16 drainage ditches, the Area 16 leachate seep, Ditch B, and the big ditch. In surface soils, arsenic was detected in Area 9 and 13 and in subsurface soils in Area 8, 14, and 15.

Both inorganic and organic forms of arsenic are readily absorbed via the oral and inhalation routes. Soluble forms are more readily absorbed than the insoluble forms (EPA 1984). Approximately 95% of soluble inorganic arsenic administered to rats is absorbed from the gastrointestinal tract (Coulson et al. 1935, Ray-Bettley and O'Shea 1975). Approximately 70%-80% of arsenic deposited in the respiratory tract of humans has been shown to be absorbed (Holland et al. 1959). Dermal absorption is not significant (EPA 1984). Acute exposure of humans to metallic arsenic has been associated with gastrointestinal effects, hemolysis, and neuropathy (EPA 1984). Chronic exposure of humans to this metal can produce toxic effects on both the peripheral and central nervous systems, keratosis, hyperpigmentation, precancerous dermal lesions, and cardiovascular damage (EPA 1984). Arsenic is embryotoxic, fetotoxic, and teratogenic in several animals species (EPA 1984). Arsenic is a known human carcinogen. Epidemiological studies of workers in smelters and in plants manufacturing arsenical pesticides have shown that inhalation of arsenic is strongly associated with lung cancer and perhaps with hepatic angiosarcoma (EPA 1984). Ingestion of arsenic has been linked to a form of skin cancer and more recently to bladder, liver, and lung cancer (Tseng 1977, Tseng et al. 1968, Chen et al. 1986).

EPA has classified arsenic in Group A--Human Carcinogen--and has developed inhalation (EPA 1988a) and (1988b) oral cancer potency factors of 50 (mg/kg/day)⁻¹ and 1.75 (mg/kg/day)⁻¹, respectively. The inhalation potency factor is the geometric mean value of potency factors derived from four

occupational exposure studies on two different exposure populations (EPA 1984). The oral cancer potency factor was based on an epidemiological study in Taiwan which indicated an increased incidence of skin cancer in individuals exposed to arsenic in drinking water (Tseng 1977). EPA (1988b) has reported an oral reference dose (RfD) of 1×10^{-3} mg/kg/day based on the study by Tseng (1977) in which blackfoot disease was observed in humans exposed to arsenic in their drinking water. An uncertainty factor of 1 was used to develop the RfD. The EPA is currently reviewing the oral RfD (EPA 1988a).

Barium

Barium was detected in the monitoring well within the production well capture zone and Area 6 groundwater wells.

Adverse effects in humans following oral exposure to soluble barium compounds include gastroenteritis, muscular paralysis, hypertension, ventricular fibrillation, and central nervous system damage (EPA 1984, Perry et al. 1983). Inhalation of barium sulfate or barium carbonate in occupationally exposed workers has been associated with baritosis, a benign pneumoconiosis (Goyer 1986). Experimental animals exposed chronically to barium in drinking water developed increased blood pressure (EPA 1984). Inhalation of barium carbonate dust by experimental animals has been associated with reduced sperm count, increased fetal mortality, and atresia of the ovarian follicles (EPA 1984 Tarasenko et al. 1977).

EPA (1988) derived an oral reference dose (RfD) based on a chronic rat study in which a lowest-observed-adverse-effect level (LOAEL) for increased blood pressure was observed (Perry et al. 1983). Using the LOAEL of 5.1 mg/kg/day and an uncertainty factor of 100, an oral RfD of 5×10^{-2} mg/kg/day was calculated. EPA (1989) has also developed an inhalation RfD of 1.4×10^{-4} mg/kg/day for barium based on a study by Tarasenko et al. (1977). In this study rats were exposed to barium carbonate dust at airborne concentrations of up to 5.2 mg/m³ for 4-6 months. Adverse effects noted at

this concentration included decreased body weight, alterations in liver function, and increased fetal mortality. An uncertainty factor of 1,000 was used in developing the RfD.

Benzene

Benzene was detected in groundwater in the production wells, the monitoring well within the production well capture zone, Area 16, and Area 17. In surface water, it was detected in Area 16 and in the big ditch. It was not detected in sediments or soils.

Benzene is readily absorbed following oral and inhalation exposure (EPA 1985). The toxic effects of benzene in humans and other animals following exposure by inhalation include central nervous system effects, hematological effects, and immune system depression. In humans, acute exposures to high concentrations of benzene vapors has been associated with dizziness, nausea, vomiting, headache, drowsiness, narcosis, coma, and death (NAS 1976). Chronic exposure to benzene vapors can produce reduced leukocyte, platelet, and red blood cell counts (EPA 1985). Benzene induced both solid tumors and leukemias in rats exposed by gavage (Maltoni et al. 1985). Many studies have also described a causal relationship between exposure to benzene by inhalation (either alone or in combination with other chemicals) and leukemia in humans (IARC 1982).

Applying EPA's criteria for evaluating the overall evidence of carcinogenicity to humans, benzene is classified in Group A (Human Carcinogen) based on adequate evidence of carcinogenicity from epidemiological studies. EPA (1988) derived both an oral and an inhalation cancer potency factor for benzene of $2.9 \times 10^{-2} \text{ (mg/kg/day)}^{-1}$. This value was based on several studies in which increased incidences of nonlymphocytic leukemia were observed in humans occupationally exposed to benzene principally by inhalation (Rinsky 1981, Ott 1978, Wong 1983). EPA is currently reviewing an oral RfD for benzene and its status is pending.

Beryllium

Beryllium was detected in all groundwater wells except the residential well and Area 9 through 14 wells. It was also detected in surface water in the Area 16 leachate seep, in sediments in the Area 16 leachate seep and drainage ditch, ditch B, and the big ditch, in Area 9 surface soil, and in Area 8 and 15 subsurface soil.

Beryllium is not readily absorbed by any route of exposure. Occupational exposure to beryllium results in bone, liver and kidney disposition (EPA 1986). In humans, acute respiratory effects due to beryllium exposure include rhinitis, pharyngitis, tracheobronchitis, and acute pneumonitis. Dermal exposure to soluble beryllium compounds can cause contact dermatitis, ulceration and granulomas (Hammond and Beliles 1980). Ocular effects include conjunctivitis and corneal ulceration from splash burns. The most common clinical symptom caused by chronic beryllium exposure is granulomatous lung inflammation (IARC 1980, EPA 1986). Chronic skin lesions sometimes appear after a long latent period in conjunction with the pulmonary effects. Systemic effects from beryllium exposure may include right heart enlargement with accompanying cardiac failure, liver and spleen enlargement, cyanosis, digital clubbing, and kidney stone development (EPA 1986). Beryllium has been shown to be carcinogenic in experimental animals resulting primarily in lung and/or bone tumors when given by injection, intratracheal administration, or inhalation (EPA 1986). Several epidemiological studies have suggested that occupational exposure to beryllium may result in an increased lung cancer risk although the data are inconclusive (EPA 1986).

Beryllium has been classified by EPA in Group B2--Probable Human Carcinogen based on increased incidences of lung cancer and osteosarcomas in animals (EPA 1988). EPA (1988) has calculated an inhalation cancer potency factor of $8.4 \text{ (mg/kg/day)}^{-1}$ based on the relative risk for lung cancer, estimated from an epidemiological study by Wagoner et al. (1980). EPA (1988) has also developed an oral reference dose (RfD) for beryllium of $5.0 \times 10^{-3} \text{ mg/kg/day}$ based on a

study by Schroeder and Mitchner (1975)' in which rats exposed to 0.54 mg/kg/day beryllium sulfate (the highest dose tested) in drinking water for a lifetime did not exhibit adverse effects; an uncertainty factor of 100 was used to develop the RfD.

Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate was detected in all groundwater wells except the production wells, the residential well, and Area 12 wells. It was also detected in surface water samples in Area 16 and in Ditch B.

Bis(2-ethylhexyl)phthalate, also known as di-ethylhexyl phthalate (DEHP), is readily absorbed following oral or inhalation exposure (EPA 1980). Chronic exposure to relatively high concentrations of DEHP in the diet can cause retardation of growth and increased liver and kidney weights in laboratory animals (NTP 1982, EPA 1980). Reduced fetal weight and increased number of resorptions have been observed in rats exposed orally to DEHP (EPA 1980). DEHP is reported to be carcinogenic in rats and mice, causing increased incidences of hepatocellular carcinomas or neoplastic nodules following oral administration (NTP 1982).

DEHP has been classified in Group B2--Probable Human Carcinogen (EPA 1986). EPA (1988) calculated an oral cancer potency factor for DEHP of 1.4×10^{-2} (mg/kg/day)⁻¹ based on data from the NTP (1982) study. EPA has recommended an oral reference dose (RfD) for DEHP of 0.02 mg/kg/day based on a study by Carpenter et al. (1953) in which increased liver weight was observed in female guinea pigs exposed to 19 mg/kg bw/day in the diet for 1 year (EPA 1988); an uncertainty factor of 1,000 was used to develop the RfD.

Cadmium

Cadmium was detected in the monitoring well within the production well capture zone, Area 2, 4, 5, 8, 9, 10, 11 and 14 groundwater well, in sediments in the

Area 13 and 16 drainage ditches, ditch B, and the big ditch, in Area 9 surface soils, and in Area 8, 14 and 15 subsurface soils.

Gastrointestinal absorption of cadmium in humans ranges from 5-6% (EPA 1985a). Pulmonary absorption of cadmium in humans is reported to range from 10% to 50% (CDHS 1986). Cadmium bioaccumulates in humans, particularly in the kidney and liver (EPA 1985a,b). Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans at a renal cortex concentration of cadmium of 200 ug/g (EPA 1985b). Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lungs, kidney, and prostate (EPA 1985b, Thun et al. 1985). In experimental animals, cadmium induces injection-site sarcomas and testicular tumors. When administered by inhalation, cadmium chloride is a potent pulmonary carcinogen in rats. Cadmium is a well-documented animal teratogen (EPA 1985b).

EPA (1988, 1989) classified cadmium as a Group B1 agent (Probable Human Carcinogen) by inhalation. This classification applies to agents for which there is limited evidence of carcinogenicity in humans from epidemiologic studies. EPA (1989) derived an inhalation cancer potency factor of $6.1 \text{ (mg/kg/day)}^{-1}$ for cadmium based on epidemiologic studies in which respiratory tract tumors were observed (Thun et al. 1985, EPA 1985b). Using renal toxicity as an endpoint, and a safety factor of 10, EPA (1980, 1987, 1988) has derived two separate oral reference doses (RfD). The RfD associated with oral exposure to drinking water is $5 \times 10^{-4} \text{ mg/kg/day}$, and is based upon the lowest-observed-adverse-effect level (LOAEL) of 0.005 mg/kg in humans (Friberg et al. 1974). The RfD associated with exposure to cadmium in food or other nonaqueous oral exposures is $1 \times 10^{-3} \text{ mg/kg/day}$.

Carbon Tetrachloride

Carbon tetrachloride (CCl_4) is readily absorbed following oral and inhalation exposure. About 60% of an oral dose was absorbed by 6 hours, and up to 86% was absorbed by 24 hours. Absorption from the lung has been estimated at about 30% (EPA 1984). CCl_4 , like many other chlorinated hydrocarbons, acts as a central nervous system depressant (ACGIH 1986). The toxic effects of oral and inhalation exposure to CCl_4 in humans and animals include damage to the liver, kidney and lung, although the liver is the most sensitive tissue (EPA 1985, Bruckner et al 1986). In animals, acute oral administration produces fatty infiltration and histological alterations in the liver. High doses produce irreversible liver damage and necrosis while the effects observed following lower doses are largely reversible (EPA 1985). Humans occupationally exposed to 5-15 ppm of CCl_4 experience biochemical alterations, nausea, headaches and in more severe cases, liver dysfunction (jaundice, enlargement and fatty infiltration) (ACGIH 1986, EPA 1984). Animals chronically exposed to CCl_4 exhibit effects similar to those observed following acute exposure. Prenatal toxicity has been demonstrated in mammalian fetuses and neonates after inhalation exposure in pregnant rats (EPA 1984), although CCl_4 has not been shown to be teratogenic (EPA 1985). Carbon tetrachloride is a carcinogen in animals producing mainly hepatic neoplasms. Oral administration of 30 mg/kg/day or higher for 6 months have been found to produce an increased frequency of hepatomas, hepatocellular adenomas and hepatocellular carcinomas in mice, rats and hamsters (EPA 1985).

EPA (1988) has classified CCl_4 as a B2 agent (probable human carcinogen). The cancer potency factor for both oral and inhalation exposure is 1.3×10^{-1} (mg/kg/day) $^{-1}$. EPA (1988) established the cancer potency factor based on several gavage studies in which hepatocellular carcinomas and hepatomas were observed in rats, mice and hamsters (Della Porta et al. 1961, Edwards et al. 1942, NCI 1976a, 1976b, 1977). EPA (1988) has derived an oral reference dose (RfD) of 7×10^{-4} mg/kg/day based on a subchronic rat gavage study in which liver lesions were the most sensitive effect (Bruckner et al. 1986). A no

observed adverse effect level (NOAEL) of 0.71 mg/kg/day and an uncertainty factor of 1,000 were used to derive the RfD.

Carcinogenic PAHs

Carcinogenic PAHs were detected in Area 18 groundwater wells and in sediments at the Area 13 drainage ditch, the Area 16 leachate seep and drainage ditch, the pond and Ditch B.

PAHs occur in the environment as complex mixtures containing numerous PAHs of varying carcinogenic potencies. Only a few components of these mixtures have been adequately characterized, and only limited information is available on the relative potencies of different compounds.

PAH absorption following oral exposure is inferred from the demonstrated toxicity of PAHs following ingestion (EPA 1984a). PAH absorption following inhalation exposure is inferred from the demonstrated toxicity of PAHs following inhalation (EPA 1984a). PAHs are also absorbed following dermal exposure (Kao et al. 1985). It has been suggested that simultaneous exposure to carcinogenic PAHs such as benzo[a]pyrene and particulate matter can increase the effective dose of the compound (ATSDR 1987). Acute effects from direct contact with PAHs and related materials are limited primarily to phototoxicity; the primary effect is dermatitis (NIOSH 1977). PAHs have also been shown to cause cytotoxicity in rapidly proliferating cells throughout the body; the hematopoietic system, lymphoid system, and testes are frequent targets (Santodonato et al. 1981). Destruction of the sebaceous glands, hyperkeratosis, hyperplasia, and ulceration have been observed in mouse skin following dermal application of the carcinogenic PAHs (Santodonato et al. 1981). The carcinogenic PAHs have also been shown to have an immunosuppressive effect in animals (ATSDR 1987). Nonneoplastic lesions are seen in animals exposed to the more potent carcinogenic PAHs only after exposure to levels well above those required to elicit a carcinogenic response. Carcinogenic PAHs are believed to induce tumors both at the site of

application and systemically. Neal and Rigdon (1967) reported that oral administration of 250 ppm benzo[a]pyrene for approximately 110 days led to forestomach tumors in mice. Thyssen et al. (1981) observed respiratory tract tumors in hamsters exposed to up to 9.5 mg/m³ benzo[a]pyrene for up to 96 weeks.

Benzo[a]pyrene is representative of the carcinogenic PAHs and is classified by EPA in Group B2--Probable Human Carcinogen--based on sufficient evidence of carcinogenicity from animal studies and inadequate evidence from epidemiological studies (EPA 1984c). EPA (1984a) calculated an oral cancer potency factor of 11.5 (mg/kg/day)⁻¹ for carcinogenic PAHs (specifically benzo[a]pyrene) based on the study by Neal and Rigdon (1967). EPA (1984a) calculated an inhalation cancer potency factor of 6.1 (mg/kg/day)⁻¹ for benzo[a]pyrene based on the study by Thyssen et al. (1981). These potency factors are currently undergoing a reevaluation based on recalculation of the data.

Chlorobenzene

Chlorobenzene was detected in the residential groundwater well.

Evidence from toxicity studies suggests that chlorobenzene is absorbed after oral, inhalation, and dermal exposure (EPA 1985). Acute and chronic exposures to chlorobenzene have been associated in humans and experimental animals with central nervous system (CNS) effects, liver and kidney lesions, and respiratory distress. Results of reproductive studies with rats and dogs also indicate that chlorobenzene induces testicular lesions (EPA 1985).

EPA (1988a,b) derived an oral chronic RfD for chlorobenzene of 3×10^{-2} mg/kg/day based on a study by Monsanto (1967) in which dogs administered chlorobenzene in capsules for 90 days exhibited liver and kidney effects; an uncertainty factor of 1,000 was used to develop the RfD. EPA (1988a,b) also reported an inhalation chronic RfD for chlorobenzene of 5×10^{-3} mg/kg/day based

on a study by Dilley (1977) in which rats exposed to chlorobenzene for 120 days exhibited liver and kidney effects; an uncertainty factor of 10,000 was used to develop the RfD.

Chloroethane

Chloroethane was detected in groundwater in the monitoring well within the production well capture zone and Area 5 wells and in surface water at the Area 16 leachate seep.

Chloroethane is primarily absorbed through the lungs, although some dermal absorption may occur. Absorption and excretion of chloroethane occurs rapidly via the lungs; it is not metabolized to a significant degree (Clayton and Clayton 1981). Severe acute inhalation of chloroethane by humans produces minor neurological effects that are manifested as stupor and lack of coordination, and in some incidences as cardiac arrhythmia produced by the potentiation of adrenalin (Clayton and Clayton 1981). Acute inhalation of chloroethane by animals has produced histological or pathological changes in the liver, brain, and lungs (Troshina 1964). Chronic exposure of animals to chloroethane produced kidney damage and fatty changes in the liver, and at high levels has upset cardiac rhythm (EPA 1985). Studies assessing the mutagenicity and carcinogenicity of chloroethane are currently being conducted (EPA 1985).

Chloroform

Chloroform was detected only in Area 17 groundwater wells.

Chloroform, a trihalomethane, is rapidly absorbed through the respiratory and gastrointestinal tracts in humans and experimental animals; dermal absorption from contact of the skin with liquid chloroform can also occur (EPA 1985). In humans, acute exposures to chloroform may result in depression of the central nervous system, hepatic and renal damage and death caused by ventricular

fibrillation following an acute ingested dose of 10 ml (EPA 1984). Acute exposure to chloroform may also cause irritation to the skin, eyes, and gastrointestinal tract (EPA 1984, 1985). In experimental animals, chronic exposure may lead to fatty cyst formation in the liver (Heywood et al. 1979), renal, and cardiac effects and central nervous system depression (EPA 1985). Chloroform has been reported to induce renal epithelial tumors in rats (Jorgenson et al. 1985) and hepatocellular carcinomas in mice (NCI 1976). Suggestive evidence from human epidemiological studies indicates that long-term exposure to chloroform and other trihalomethanes in contaminated water supplies may be associated with an increased incidence of bladder tumors (EPA 1985).

Chloroform has been classified by EPA as a Group B2 Carcinogen (Probable Human Carcinogen) (EPA 1988). EPA (1988) developed an oral cancer potency factor for chloroform of 6.1×10^{-3} (mg/kg/day)⁻¹ based on a study in which kidney tumors were observed in rats exposed to chloroform in drinking water (Jorgenson et al. 1985). An inhalation cancer potency factor of 8.1×10^{-2} (mg/kg/day)⁻¹ has been developed by EPA (1988) based on an NCI (1976) bioassay in which liver tumors were observed in mice. EPA (1988) also derived an oral reference dose (RfD) of 0.01 mg/kg/day for chloroform based on a chronic bioassay in dogs in which liver effects were observed at 12.9 mg/kg/day (Heywood et al. 1979); an uncertainty factor of 1,000 was used to derive the RfD.

Chromium

Chromium was detected in the monitoring well within the production well capture zone, Area 2 through 8, 11, 12, 14, 16 and 17 groundwater wells, and the residential well. It was also detected in surface water in the Area 13 drainage ditch, in sediments in the Area 13 drainage ditch, Ditch A, Ditch B, the big ditch, and the unnamed ditch, and in surface soils in Areas 9 and 13.

Chromium exists in two states, as chromium (III) and as chromium (VI). Following oral exposure, absorption of chromium (III) is low while absorption of chromium (VI) is high (EPA 1987). Chromium is an essential micronutrient and is not toxic in trace quantities (EPA 1980). High levels of soluble chromium (VI) and chromium (III) can produce kidney and liver damage following acute oral exposure; target organs affected by chronic oral exposure remain unidentified (EPA 1984). Chronic inhalation exposure may cause respiratory system damage (EPA 1984). Further, epidemiological studies of worker populations have clearly established that inhaled chromium (VI) is a human carcinogen; the respiratory passages and the lungs are the target organs (Mancuso 1975, EPA 1984). Inhalation of chromium (III) or ingestion of chromium (VI) or (III) has not been associated with carcinogenicity in humans or experimental animals (EPA 1984). Certain chromium salts have been shown to be teratogenic and embryotoxic in mice and hamsters following intravenous or intraperitoneal injection (EPA 1984).

EPA has classified inhaled chromium (VI) in Group A--Probable Human Carcinogen by the inhalation route (EPA 1988b). Inhaled chromium (III) and ingested chromium (III) (EPA 1988a) and (VI) (EPA 1988b) have not been classified with respect to carcinogenicity. EPA (1988b) developed an inhalation cancer potency factor of $41 \text{ (mg/kg/day)}^{-1}$ for chromium (VI) based on an increased incidence of lung cancer in workers exposed to chromium over a 6 year period, and followed for approximately 40 years (Mancuso 1975). EPA (1988b) derived an oral reference dose (RfD) of $5.0 \times 10^{-3} \text{ mg/kg/day}$ for chromium (VI) based on a study by MacKenzie et al. (1958) in which no observable adverse effects were observed in rats exposed to 2.4 mg chromium (VI)/kg/day in drinking water for 1 year. A safety factor of 500 was used to derive the RfD. EPA (1988a) developed an oral RfD of 1 mg/kg/day for chromium (III) based on a study in which rats were exposed to chromic oxide baked in bread; no effects due to chromic oxide treatment were observed at any dose level (Ivankovic and Preussman 1975). A safety factor of 1000 was used to calculate the oral RfD.

Copper

Copper was detected in all groundwater wells, in all surface water areas except the unnamed ditch, in all but ditch A, big ditch, and unnamed ditch sediments, in Area 9 surface soils, and in Area 8 and 15 subsurface soils.

Copper is an essential element. A daily copper intake of 2 mg is considered to be adequate for normal health and nutrition; the minimum daily requirement is 10 $\mu\text{g/kg}$ (EPA 1985). In humans, absorption of copper following oral exposure is approximately 60% and is influenced by competition with other metals and the level of dietary protein and ascorbic acid in both humans and animals (EPA 1984). Copper is absorbed following inhalation exposures, although quantitative data on the extent of absorption are unavailable (EPA 1984). Adverse effects in humans resulting from acute exposure to copper at concentrations that exceed these recommended levels by ingestion include salivation, gastrointestinal irritation, nausea, vomiting, hemorrhagic gastritis, and diarrhea (ACGIH 1986). Dermal or ocular exposure of humans to copper salts can produce irritation (ACGIH 1986). Acute inhalation of dusts or mists of copper salts by humans may produce irritation of the mucous membranes and pharynx, ulceration of the nasal septum, and metal fume fever. The latter condition is characterized by chills, fever, headache, and muscle pain. Limited data are available on the chronic toxicity of copper; however, chronic over-exposure to copper by humans has been associated with anemia (ACGIH 1986) and local gastrointestinal irritation (EPA 1987). Results of several animal bioassays suggest that copper compounds are not carcinogenic by oral administration; however, some copper compounds can induce injection-site tumors in mice (EPA 1985).

EPA (1988) has reported a drinking water standard of 1.3 mg/liter based on local gastrointestinal irritation (EPA 1987). Assuming a 70-kg adult ingests 2 liters of water per day, this concentration is equivalent to a dose of 3.7×10^{-2} mg/kg/day. However, EPA (1987) concluded toxicity data were inadequate for the calculation of a reference dose (RfD) for copper.

Cyanide

Cyanide was detected in surface soils in Area 9.

The toxicity of cyanides is strongly dependent on their chemical speciation. Free cyanides are readily absorbed from the gastrointestinal tract, lungs, and skin and, once absorbed, are rapidly distributed throughout the body (EPA 1985). The toxic effects in humans following acute oral exposure to free cyanides include hyperventilation, vomiting, unconsciousness, convulsions, vascular collapse and cyanosis, and death (EPA 1985). Inhalation of high concentrations of hydrogen cyanide (HCN) gas results in almost immediate collapse, respiratory arrest, and death within minutes (DiPalma 1971). Airborne hydrogen cyanide concentrations between 99 and 528 mg/m³ are fatal within 30-60 minutes (NIOSH 1976). There is limited data on chronic exposures of cyanide in humans, although the following effects have been identified in chronic occupationally exposed workers in some epidemiologic studies: neurological dysfunction, lacrimation, abdominal pain, muscular weakness, and shortness of breath (NIOSH 1976). Cyanide appears to be less toxic to animals following chronic exposures than following acute exposures. In animals, chronic oral exposure has produced weight loss, thyroid effects and myelin degeneration (Howard and Hanzal 1955). Cyanide can cause teratogenic effects when subcutaneously administered to hamsters; this teratogenic effect has not been observed in other species although some reproductive toxicity has been noted (EPA 1985).

EPA (1988, 1989) calculated an oral reference dose (RfD) of 0.02 mg/kg/day for cyanide based on a chronic study by Howard and Hanzal (1955) in which rats were maintained on a diet fumigated with hydrogen cyanide and exhibited weight loss, thyroid effects and myelin degeneration. No observed adverse effects (NOAEL) were noted at the highest dose administered (10.8 mg/kg/day). A NOAEL of 10.8 mg/kg/day and a safety factor of 500 were used to derive the RfD (EPA 1988).

1,2-Dichloroethane

1,2-Dichloroethane was detected in groundwater in the monitoring well within the production well capture zone and in Area 16 wells.

Data on the toxicokinetics of 1,2-dichloroethane (1,2-DCA) in humans are limited, but data from animal studies suggest that the chemical is rapidly absorbed following oral and inhalation exposure and after dermal contact with the liquid form of the compound (EPA 1985). Effects of acute inhalation exposure in humans include irritation of mucous membranes in the respiratory tract and central nervous system depression (EPA 1985). Death may occur as a result of respiratory and circulatory failure. Pathological examinations typically show congestion, degeneration, necrosis, and hemorrhagic lesions of the respiratory and gastrointestinal tracts, liver, kidney, spleen, and lungs (EPA 1985). Adverse effects caused by less extreme exposures are generally associated with the gastrointestinal and nervous systems. Occupational exposures to 1,2-DCA vapors result in anorexia, nausea, vomiting, fatigue, nervousness, epigastric pain, irritation of the eyes and respiratory tract, and gastrointestinal, liver, and gallbladder disease (EPA 1984, 1985). Chronic studies in animals also have revealed toxic effects following inhalation exposure including degeneration of the liver (EPA 1985). Available data suggest that 1,2-DCA does not adversely affect reproductive or developmental processes in experimental animals except at maternally toxic levels (EPA 1985). In long-term oral bioassays sponsored by the National Cancer Institute (NCI 1978), increased incidences of squamous-cell carcinomas of the forestomach, mammary gland adenocarcinomas, and hemangiosarcomas have been observed in rats exposed to 1,2-DCA; pulmonary adenomas, mammary adenocarcinomas, and uterine endometrial tumors have been observed in mice exposed to this chemical.

EPA (1988) has classified 1,2-DCA in Group B2 (Probable Human Carcinogen) based on inadequate evidence of carcinogenicity from human studies and

sufficient evidence of carcinogenicity from animal studies. EPA (1988) derived an oral and an inhalation cancer potency factor (q_1^*) of 9.1×10^{-2} (mg/kg/day)⁻¹ for 1,2-DCA based on the incidences of hemangiosarcomas in Osborne-Mendel male rats observed in the NCI (1978) gavage study.

1,1-Dichloroethene

1,1-Dichloroethene was detected in the monitoring well within the production well capture zone, Area 3, 5, 16, and 18 groundwater wells.

1,1-Dichloroethene (1,1-DCE) is rapidly absorbed after oral and inhalation exposures (EPA 1984, 1987). Humans acutely exposed to 1,1-DCE vapors exhibit central nervous system depression. In animals, the liver is the principal target of 1,1-DCE toxicity. Acute exposures result in liver damage which ranges from fatty infiltration to necrosis (EPA 1987). Workers chronically exposed to 1,1-DCE in combination with other vinyl compounds exhibit liver dysfunction, headaches, vision problems, weakness, fatigue and neurological sensory disturbances (EPA 1987). Chronic oral administration of 1,1-DCE to experimental animals results in both hepatic and renal toxicity (EPA 1984). Inhalation or oral exposure of rats and rabbits has produced fetotoxicity and minor skeletal abnormalities, but only at maternally toxic doses. 1,1-DCE vapors produced kidney tumors and leukemia in a single study of mice exposed by inhalation, but the results of other studies were equivocal or negative (EPA 1987, Maltoni et al. 1985).

EPA has classified 1,1-DCE as a Group C agent (Possible Human Carcinogen) and has developed inhalation and oral cancer potency factors of 1.2 (mg/kg/day)⁻¹ and 0.6 (mg/kg/day)⁻¹, respectively (EPA 1985, 1988). The inhalation potency factor was based on the increased incidence of renal adenocarcinomas in male mice exposed to 1,1-DCE via inhalation for 52 weeks and observed for a total of 121 weeks (Maltoni et al. 1985). The oral potency factor was derived by estimating an upper-limit value from negative bioassay data and assuming that a carcinogenic response occurs via ingestion, although there is no direct

evidence that this is true. EPA (1988) developed an oral reference dose (RfD) of 9×10^{-3} mg/kg/day based on the occurrence of hepatic lesions in rats chronically exposed to 1,1-DCE in drinking water (Quast et al. 1983). A safety factor of 1000 was applied to the lowest-observed-adverse-effect level (LOAEL) of 9 mg/kg/day to derive the oral RfD.

trans-1,2-Dichloroethene

trans-1,2-Dichloroethene was detected in the production wells, Area 2, 5, 8, 16, and 17 groundwater wells and in surface water in the Area 16 leachate seep.

trans-1,2-Dichloroethene is expected to be absorbed by any route of exposure. Information on the health effects of *trans*-1,2-dichloroethene is limited. In humans, *trans*-1,2-dichloroethene is a central nervous system depressant, and exposure to high concentrations can result in anesthetic effects (Irish 1963). Inhalation exposure of rats to 200 ppm has been associated with pneumonic infiltration of the lungs and progressive fatty degeneration of the liver (Freundt et al. 1977). Acute exposure to higher dose levels can cause narcosis and death in rats (Torkelson and Rowe 1981).

EPA (1985) proposed a maximum contaminant level goal (MCLG) of 70 μ g/liter for both *cis*- and *trans*-1,2-dichloroethene based on the adjusted acceptable daily intake (AADI) of 350 μ g/liter, assuming 20% of the exposure is via drinking water. EPA (1988) has derived an oral reference dose (RfD) of 2×10^{-2} mg/kg/day for *trans*-1,2-dichloroethene based on a 90-day drinking water study conducted in mice (Barnes et al. 1985). A no-observed-adverse-effect level (NOAEL) of 17 mg/kg/day for increased serum alkaline phosphatase and an uncertainty factor of 1,000 were used to derive the RfD.

1,2-Dichloropropane

1,2-Dichloropropane was only detected in Area 17 groundwater wells.

1,2-Dichloropropane is absorbed following ingestion and inhalation exposure. Adverse effects associated with acute exposure in humans have included CNS depression, narcosis, headache, and mucous membrane irritation. In animals, effects associated with acute exposure have included histopathological changes in the liver, kidney, and adrenals. Altered serum enzyme activities were also reported (EPA 1985). Chronic or subchronic exposure of experimental animals to 1,2-dichloropropane has been associated with reduced body weight, liver necrosis, centrilobular congestion, altered CNS function, and altered serum enzyme activities (EPA 1985). DeLorenzo et al. (1977) reported that 1,2-dichloropropane induced reverse and forward mutations in some test species. The compound also induced sister chromatid exchanges and chromosomal aberrations in Chinese hamster ovary cells *in vitro* (NTP 1986). 1,2-Dichloropropane caused a dose-related increased incidence of hepatocellular adenomas in rats (NTP 1986).

1,2-Dichloropropane is categorized in Group B2--Probable Human Carcinogen (EPA 1989). This chemical has an oral cancer potency factor of 6.8×10^{-2} (mg/kg/day)⁻¹ based on an increased incidence of hepatocellular adenomas in mice in the study conducted by NTP (1986) (EPA 1989).

1,3-DNB

1,3-DNB was detected in the monitoring well within the production well capture zone, Area 4, 6, and 16 groundwater wells.

Absorption of the dinitrobenzene (DNB) isomers (1,2-DNB, 1,3-DNB, and 1,4-DNB) have not been well characterized, however ready absorption through the skin is a major factor in its toxicity (ACGIH 1986). Occupational exposures to the DNB isomers have been associated with methemoglobinemia and respiratory tract

irritation. Prolonged exposures of humans to dinitrobenzene may result in anemia, liver damage and cyanosis (Beard and Noe 1981). In animals, subchronic oral exposures have resulted in retarded growth, decreased hemoglobin concentrations, splenic enlargement and hemosiderin deposits. Testicular atrophy and decreased spermatogenesis have also been observed in male rats following oral exposures (Cody et al. 1981).

EPA 1988 has developed an oral reference dose (RfD) of 1.0×10^{-4} mg/kg/day for 1,3-DNB based on a subchronic drinking water study in rats. This study identified a lowest-observed-effect-level (LOEL) of 8 ppm for increased splenic weight and a no-observed-effect-level (NOAEL) of 3 ppm (0.40 mg/kg/day) (Cody et al. 1981). The RfD was calculated using the NOAEL and an uncertainty factor of 3000.

2,4 and 2,6 - Dinitrotoluene

Both 2,4-DNT and 2,6-DNT were detected in the monitoring well within the production well capture zone and in Area 17 groundwater wells. 2,4-DNT was also detected in Area sediments in Ditch A. 2,6-DNT was also detected in Area 2 groundwater wells and in Area 8 subsurface soils.

Dinitrotoluene (DNT) is rapidly absorbed following inhalation, dermal and oral exposure, and once absorbed, is distributed throughout the body. DNT undergoes oxidative and reductive metabolism with the primary sites of metabolic activity in the liver and small intestine (Schut et al. 1982). The blood, liver, and neuromuscular systems are the primary target organs for DNT toxicity in both humans and experimental animals. In humans, symptoms resulting from subchronic and chronic exposures to DNT include cyanosis, dizziness, headaches, dyspnea and brown urine (Etnier 1987). Long term occupational exposures also have been correlated with an increase in ischemic heart disease (Levine et al. 1986). In rats, chronic exposure to mixtures of 2,4- and 2,6-DNT in the diet has been reported to significantly increase the incidence of liver tumors (Ellis et al. 1979). Bioassays using the individual

isomers indicate that most of the carcinogenicity of 2,4-DNT/2,6-DNT mixtures can be attributed to the 2,6-isomer, and that pure 2,4-DNT is not carcinogenic (Leonard et al. 1987). These data are not conclusive, however.

EPA (1988) reported an oral potency factor for 2,4-DNT of $0.68 \text{ (mg/kg/day)}^{-1}$. Etnier (1987) developed an oral potency factor of $4.83 \text{ (mg/kg/day)}^{-1}$ for 2,6-DNT. The potency factor for 2,4-DNT was derived based on the study of Ellis et al. (1979) in which progressive development of hepatocellular carcinomas was reported in male and female Charles River CD rats following exposure doses of 35 and 45 mg/kg/day, respectively, for more than a year. The potency factor for 2,6-DNT was derived using the data of Leonard et al. (1987) which indicated a statistically significant increase in the incidence of hepatocarcinomas in male Fischer 344 rats fed 7 and 14 mg/kg/day pure 2,6-DNT for 1 year.

Di-n-butyl phthalate

Di-n-butyl phthalate was detected only in sediments in the Area 16 drainage ditch.

Di-n-butyl phthalate is readily absorbed following oral and inhalation exposure (EPA 1980). Acute exposures of di-n-butyl phthalate aerosol in mice have produced irritation of the eyes and upper respiratory tract mucous membranes. Extreme exposures result in labored breathing, ataxia, paresis, convulsions and death from paralysis of the respiratory system (ACGIH 1986). Workers chronically exposed to di-n-butyl phthalate in combination with other phthalate plasticizers have exhibited pain, numbness and spasms in the upper and lower extremities. Further evaluation revealed vestibular dysfunction and polyneuritis (ACGIH 1986). Reduced fetal weight, increased numbers of resorptions, and dose-related musculoskeletal abnormalities have been observed among fetuses from rats and mice exposed to very high doses of di-n-butyl phthalate during gestation (Shiota and Nishimura 1982).

EPA (1988) calculated an oral reference dose (RfD) for di-n-butyl phthalate based on a study by Smith (1953) in which male Sprague-Dawley rats were fed a diet containing dibutyl phthalate for a period of 1 year. One-half of all rats receiving the highest dibutyl phthalate concentration (1.25% of diet, or 600 mg/kg/day) died during the first week of exposure. The remaining animals survived the study with no apparent adverse effects. Using a NOAEL of 125 mg/kg/day (0.25% dibutyl phthalate in diet) and an uncertainty factor of 1,000, an oral reference dose (RfD) of 0.1 mg/kg/day was derived; a LOAEL of 600 mg/kg/day (1.25% dibutyl phthalate in diet) was observed in this study.

Di-n-octyl phthalate

Di-n-octyl phthalate was detected in the monitoring well within the production well capture zone, Area 1, 10, and 16 groundwater wells.

Di-n-octyl phthalate is not especially toxic. It is a severe eye and a mild skin irritant in rabbits (NIOSH 1985, NTP/IRLG 1982, EPA 1980). Fetotoxicity and developmental abnormalities were observed in the offspring of rats administered 5 g/kg intraperitoneal injections on days 6 to 15 of gestation (NTP/IRLG 1982, EPA 1980).

Ethylbenzene

Ethylbenzene was detected in Area 17 groundwater wells and in surface water in the Area 16 leachate seep.

Ethylbenzene is absorbed via inhalation and distributed throughout the body in rats; the highest levels were detected in the kidney, lung, adipose tissue, digestive tract, and liver (Chin et al. 1980). In humans, short-term inhalation exposure to 435 mg/m³ ethylbenzene for 8 hours can result in sleepiness, fatigue, headache, and mild eye and respiratory irritation (Bardodej and Bardodejova 1970); eye irritation has also been observed in experimental animals exposed to ethylbenzene (EPA 1987). Increased weights

and cloudy swelling were observed in the liver and kidney of rats exposed to ethylbenzene by stomach tube at a dose of 408 mg/kg/day for 182 days (Wolf et al. 1956). A single oral dose of ethylbenzene administered by stomach tube to male and female Wistar-derived rats was reported to have an LD₅₀ of 3,500 mg/kg body weight, with systemic effects occurring primarily in the liver and kidney (Wolf et al. 1956). Maternal toxicity was observed in rats exposed by inhalation to 4,348 mg/m³ ethylbenzene for 6-7 hours/day during the first 19 days of gestation (Hardin et al. 1981).

EPA (1988) derived an oral reference dose of 0.1 mg/kg/day for ethylbenzene based on the chronic study by Wolf et al. (1956) in which no liver or kidney effects were observed in rats exposed to 136 mg/kg/day. An uncertainty factor of 1,000 was applied to the no-observed-effect-level to derive the reference dose.

HMX

HMX was detected in the monitoring well within the production well capture zone, Area 3, 4, 6, 7, 11, 12, 17 and 18 groundwater wells and in surface water in Ditch A.

HMX is absorbed to a very limited extent following oral exposure. In rats and mice, between 70 and 85% of the administered dose was eliminated in the feces within 4 days (Cameron 1986). No data were found in the available literature regarding pulmonary or dermal absorption.

EPA (1988) developed an RfD based on a subchronic study in which groups of 20 male and 20 female Fischer 344 rats received HMX in the diet for 13 weeks (Everett et al. 1985). Dietary concentrations corresponded to dosages of 0, 50, 150, 450, 1350 and 4000 mg/kg bw for males and 0, 50, 115, 270, 620 and 1500 mg/kg bw for the females. Histopathologic changes were observed in the liver of males at the three highest dose levels, and in the kidneys of females in the three highest dose groups, indicating sexual differences in the target

organ responses of rats. Based on these results, lowest-observed-adverse-effect levels (LOAEL) of 150 and 270 mg/kg/day and no-observed-adverse-effect levels (NOAEL) of 50 and 115 mg/kg/day were identified for males and females, respectively. The RfD of 0.05 mg/kg/day was derived by applying an uncertainty factor of 1000 to the NOAEL for males.

Lead

Lead was detected in groundwater in all areas except the residential wells, in surface water in Area 13 and 16 drainage ditches, the Area 16 leachate seep, and ditch B, in sediments in all areas sampled, in Area 9 and 13 surface soils, and in Area 8 and 15 subsurface soils.

Absorption of lead from the gastrointestinal tract of humans is estimated at 10%-15%. For adult humans, the deposition rate of particulate airborne lead is 30%-50%, and essentially all of the lead deposited is absorbed. Lead is stored in the body in the kidney, liver and bone (EPA 1984). The major adverse effects in humans caused by lead include alterations in the hematopoietic and nervous systems. The toxic effects are generally related to the concentration of this metal in blood. Blood concentration levels of over 80 µg/dl in children and over 100 µg/dl in sensitive adults can cause severe, irreversible brain damage, encephalopathy, and possible death. Lower blood concentrations of lead (30-40 µg/dl) have been associated in humans with altered nerve conduction, altered testicular function, renal dysfunction, and anemia. Lead exposure also has been associated in humans with spontaneous abortions, premature delivery, and early membrane rupture in humans; however, reliable exposure estimates are lacking in these cases. Decreased fertility, fetotoxic effects, and skeletal malformations have been observed in experimental animals exposed to lead (EPA 1984). Chronic oral ingestion of certain lead salts (lead acetate, lead phosphate, lead subacetate) has been associated in experimental animals with increased renal tumors. Doses of lead that induced kidney tumors were high and were beyond the lethal dose in humans (EPA 1985).

EPA classified certain lead salts in Group B2--Probable Human Carcinogen (EPA 1985), although no cancer potency factor has been established (EPA 1988). This category applies to those agents for which there is sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans. EPA (1985) has noted that the available data provide an insufficient basis on which to regulate lead acetate, phosphate and subacetate as human carcinogens. EPA (1988) has also considered it inappropriate to develop a reference dose (RfD) for inorganic lead and lead compounds, since many of the health effects associated with lead intake occur essentially without a threshold.

Mercury

Mercury was detected in the Area 13 drainage ditch surface waters and sediments, in ditch B sediments, in Area 9 surface soils, and in Area 8 and 9 subsurface soils.

In humans, inorganic mercury is absorbed following inhalation and oral exposure, however only 7% to 15% of administered inorganic mercury is absorbed following oral exposure (EPA 1984, Rahola et al. 1971, Task Group on Metal Accumulation 1973). Organic mercury is almost completely absorbed from the gastrointestinal tract and is assumed to be well absorbed via inhalation in humans (EPA 1984). A primary target organ for inorganic compounds is the kidney. Acute and chronic exposures of humans to inorganic mercury compounds have been associated with anuria, polyuria, proteinuria, and renal lesions (Hammond and Beliles 1980). Chronic occupational exposure of workers to elemental mercury vapors (0.1 to 0.2 mg/m³) has been associated with mental disturbances, tremors, and gingivitis (EPA 1984). Animals exposed to inorganic mercury for 12 weeks have exhibited proteinuria, nephrotic syndrome and renal disease (Druet et al. 1978). Rats chronically administered inorganic mercury (as mercuric acetate) in their diet have exhibited decreased body weights and significantly increased kidney weights (Fitzhugh et al.

1950). The central nervous system is a major target for organic mercury compounds. Adverse effects in humans, resulting from subchronic and chronic oral exposures to organic mercury compounds have included destruction of cortical cerebral neurons, damage to Purkinje cells, and lesions of the cerebellum. Clinical symptoms following exposure to organic mercury compounds have included paresthesia, loss of sensation in extremities, ataxia, and hearing and visual impairment (WHO 1976). Embryotoxic and teratogenic effects, including malformations of the skeletal and genitourinary systems, have been observed in animals exposed orally to organic mercury (EPA 1984). Both organic and inorganic compounds are reported to be genotoxic in eukaryotic systems (Leonard et al. 1984).

EPA (1989) has reported an oral RfD for methyl mercury of 3×10^{-4} mg/kg/day based on studies investigating central nervous system effects in humans exposed to mercury (EPA 1980); an uncertainty factor of 10 was used to develop the RfD. EPA (1989) has also reported an oral reference dose of 3×10^{-4} mg/kg/day for inorganic mercury based on a chronic rat study in which kidney effects were observed (Fitzhugh et al. 1950). An uncertainty factor of 1,000 was used to derive the RfD.

Methylene chloride

Methylene chloride was detected in Area 5, 7, and 17 groundwater wells.

Methylene chloride is absorbed following oral and inhalation exposure. The amount of airborne methylene chloride absorbed following inhalation exposure increases in direct proportion to its concentration in inspired air, the duration of exposure, and physical activity. Dermal absorption has not been accurately measured (EPA 1988). Acute human exposure to methylene chloride may result in irritation of eyes, skin, and respiratory tract; central nervous system depression; elevated carboxyhemoglobin levels; and circulatory disorders that may be fatal. Chronic exposure of animals can produce renal and hepatic toxicity (EPA 1988). Methylene chloride is mutagenic for

Salmonella typhimurium and produces mitotic recombination in yeast (EPA 1988). Several inhalation studies conducted in animals provide clear evidence of methylene chloride's carcinogenicity. There is only suggestive evidence in experimental animals that hepatocellular carcinomas and neoplastic nodules arise from oral exposure (EPA 1985a,b).

EPA (1989) classified methylene chloride in Group B2--Probable Human Carcinogen. It has been concluded by EPA (1985b) that the induction of distant site tumors from inhalation exposure and the borderline significance for induction of tumors in a drinking water study are an adequate basis for concluding that methylene chloride be considered a probable human carcinogen via ingestion as well as inhalation. EPA (1989) derived an inhalation cancer potency factor of $1.4 \times 10^{-2} \text{ (mg/kg/day)}^{-1}$ based on the results of a National Toxicology Program (NTP) inhalation bioassay conducted in rats and mice (NTP 1986). Mammary tumors were noted in rats, while lung and liver tumors were observed in mice. EPA (1988) determined an oral cancer potency factor of $7.5 \times 10^{-3} \text{ (mg/kg/day)}^{-1}$ based on the results of the NTP (1986) inhalation bioassay and on an ingestion bioassay conducted by the National Coffee Association (NCA 1983). In the NCA study, hepatocellular adenomas and/or carcinomas were observed in male mice. An oral reference dose (RfD) of 0.06 mg/kg/day has been developed by EPA (1989) based on a 2-year rat drinking water bioassay (NCA 1982) that identified no-observed-effect levels (NOELs) of 5.85 and 6.47 mg/kg/day for male and female rats, respectively. Liver toxicity was observed at doses of 52.58 and 58.32 mg/kg/day for males and females, respectively. An uncertainty factor of 100 was used to derive the RfD.

Nickel

Nickel was detected in all areas where groundwater leachate seep and drainage ditch, ditches A and B, and the big ditch, and in sediments in the Area 13 drainage ditch and the big ditch.

Nickel compounds can be absorbed following inhalation, ingestion, or dermal exposure. The amount absorbed depends on the dose administered and the chemical and physical form of the particular nickel compound (EPA 1986). Dermal exposure of humans to nickel produces allergic contact dermatitis (EPA 1986). Adverse effects associated with acute exposure in animals have included depressed weight gain, altered hematological parameters, and increased iron deposition in blood, heart, liver, and testes (EPA 1987). Chronic or subchronic exposure of experimental animals to nickel has been associated with reduced weight gain, degenerative lesions of the male reproductive tract, asthma, nasal septal perforations, rhinitis, sinusitis, hyperglycemia, decreased prolactin levels, decreased iodine uptake, and vasoconstriction of the coronary vessels (EPA 1986). Teratogenic and fetotoxic effects have been observed in the offspring of exposed animals (EPA 1986). Inhalation exposure of experimental animals to nickel carbonyl or nickel subsulfide induces pulmonary tumors (EPA 1986). Several nickel salts cause localized tumors when administered by subcutaneous injection or implantation. Epidemiological evidence indicates that inhalation of nickel refinery dust and nickel subsulfide is associated with cancers of the nasal cavity, lung, larynx, kidney, and prostate (EPA 1986).

Nickel refinery dust and nickel subsulfide are both categorized in Group A--Human Carcinogens. These classifications are based on an increase incidence of lung and nasal tumors observed in workers occupationally exposed to nickel refinery dust. These materials have inhalation cancer potency factors of $0.84 \text{ (mg/kg/day)}^{-1}$ and $1.7 \text{ (mg/kg/day)}^{-1}$, respectively (EPA 1988). Nickel carbonyl is categorized in Group B2--Probable Human Carcinogen; however, a potency factor has not been derived for nickel carbonyl (EPA 1988). EPA (1988) derived an oral reference dose (RfD) for nickel of $2 \times 10^{-2} \text{ mg/kg/day}$ based on a study by Ambrose et al. (1976) in which rats administered 5 mg/kg/day (NOAEL) nickel in the diet for 2 years did not experience decreased weight gain observed in animals administered 50 mg/kg/day (LOAEL). A safety factor of 300 was used to calculate the RfD.

Nitrobenzene

Nitrobenzene was detected only in Area 16 groundwater wells.

Nitrobenzene is absorbed by all possible routes, but absorption primarily occurs through the respiratory tract and skin (EPA 1980); approximately 80% of inhaled nitrobenzene is absorbed (EPA 1980). In humans long-term occupational exposure to nitrobenzene can result in cyanosis, methemoglobinemia, jaundice, anemia, sulfhemoglobinemia, and dark urine (EPA 1980). Short-term exposure to high levels of nitrobenzene can result in cyanosis, and if severe, the individual can go into a coma (Piotrowski 1967). Hematologic, adrenal, renal, and hepatic lesions have been reported in rats and mice exposed to nitrobenzene in air for 90 days (CIIT 1984). There is also limited evidence that exposure to nitrobenzene can result in changes in the tissues of the chorion and placenta in pregnant women (Dorigan and Hushon 1976); menstrual disturbances after chronic nitrobenzene exposure have also been reported (EPA 1980).

EPA (1988a) developed an inhalation RfD for nitrobenzene of 6×10^{-4} mg/kg/day based on a study in which hematological, adrenal, renal, and hepatic lesions were observed in mice following inhalation exposure to nitrobenzene (CIIT 1984) and using an uncertainty factor of 10,000. EPA (1988b) also developed an oral RfD for nitrobenzene of 5×10^{-4} mg/kg/day based on the CIIT study based on route-to-route extrapolation and using an uncertainty factor of 10,000 (EPA 1988).

N-nitrosodiphenylamine

N-nitrosodiphenylamine was detected in the monitoring well within the production well capture zone, Area 8 and 12 groundwater wells.

N-Nitrosodiphenylamine (NDPA) is absorbed following ingestion. In rats NDPA can cross the placenta (EPA 1980). Its acute oral toxicity in rats is very

low (Druckrey et al. 1967). In subchronic feeding studies conducted in rats, weight reduction was reported. Trace amounts of pigmentation were observed in hepatic Kupffer cells of male mice (NCI 1979). When NDPA was administered to rats late in pregnancy, neoplasms were induced in the offspring (EPA 1980). Significant increases in the incidence of urinary bladder carcinomas in male and female rats were reported. A dose related trend in fibromas of the subcutis and skin among male rats was also observed (NCI 1979).

NDPA by ingestion is categorized in Group B2--Probable Human Carcinogen. This compound has an oral cancer potency factor of 4.9×10^{-3} (mg/kg/day)⁻¹ (EPA 1988). This value was based on an increased incidence of bladder tumors in male and female rats (NCI 1979).

Noncarcinogenic PAHs

Noncarcinogenic PAHs were detected in Area 1 groundwater wells and in sediments in the Area 13 drainage ditch, the Area 16 drainage ditch, the pond and Ditch B.

Polycyclic aromatic hydrocarbons (PAHs) occur in the environment as complex mixtures of which only a few components have been adequately characterized. Only limited information is available on the relative potencies of the "noncarcinogenic" PAHs. However, many have been shown to have some weak carcinogenic activity, or to act as promoters or cocarcinogens.

PAH absorption following oral and inhalation exposure is inferred from the demonstrated toxicity of PAHs following these routes of administration (EPA 1984a). PAHs are also absorbed following dermal exposure (Kao et al. 1985). Acute effects from direct contact with PAHs and related materials are limited primarily to phototoxicity; the primary effect is dermatitis (NIOSH 1977). PAHs have also been shown to cause cytotoxicity in rapidly proliferating cells throughout the body; the hematopoietic system, lymphoid system, and testes are frequent targets (Santodonato et al. 1981). Some of the noncarcinogenic PAHs

have been shown to cause systemic toxicity but these effects are generally seen at high doses (Santodonato et al. 1981). Slight morphological changes in the liver and kidney of rats have been reported following oral exposure to acenaphthene for 40 days (EPA 1984a). Subchronic oral administration of naphthalene to rabbits and rats has resulted in cataract formation (EPA 1984b). EPA (1988) developed an oral reference dose of 0.4 mg/kg/day for naphthalene based on the development of ocular and systemic lesions in rats (Schmahl 1955, EPA 1986) and occupational data on coke oven workers. An uncertainty factor of 100 was applied to the animal data in the development of the reference dose.

Phenol

Phenol was detected only in surface water in the Area 16 leachate seep.

Phenol is readily absorbed through the gut, by inhalation, and percutaneously (EPA 1980). Signs of acute phenol toxicity in humans and experimental animals are central nervous system depression, collapse, coma, cardiac arrest, and death. Acutely toxic doses can also cause extensive necrosis at the site of exposure (eyes, skin, oropharynx) (EPA 1980). In experimental animals subchronic oral and inhalation studies suggest that kidney, pulmonary, myocardial, and liver damage are associated with exposure, although many of these studies were poorly designed (EPA 1980, 1984). Phenol exhibited tumor-promoting activity in the mouse skin painting system following initiation with 9,10-dimethyl-1,2-benzanthracene (DMBA) or benzo[a]pyrene (B[a]P), and it exhibited cutaneous carcinogenic activity in a sensitive mouse strain when applied at concentrations that produced repeated skin damage (EPA 1980).

The oral RfD calculated by EPA (1988) has been withdrawn and is pending further review. An inhalation acceptable intake chronic (AIC) of 1.4 mg/person/day (0.02 mg/kg/day) was recommended by EPA (1984) based on the threshold limit value of 19 mg/m³ phenol established by the American

Conference of Governmental Industrial Hygienists (ACGIH 1983). EPA has not yet established an inhalation RfD (EPA 1988).

RDX

RDX was detected in all groundwater wells except the production wells and the residential well.

RDX is slowly absorbed in humans and laboratory animals following oral and inhalation exposures (Etnier 1986). No data are available regarding dermal absorption, but because RDX is relatively lipid insoluble, skin absorption is unlikely (Rosenblatt 1980). In humans, the toxic effects of RDX have been on the central nervous system (CNS). Chronic exposures in humans have been associated with generalized convulsions and unconsciousness, followed by temporary amnesia and disorientation (Stokinger et al. 1982). In animals, hepatotoxicity, anemia, and testicular and urogenital lesions have been reported following chronic exposures, in addition to CNS effects (Levine et al. 1983).

No conclusive evidence of carcinogenicity has been shown for RDX. RDX was not found to be carcinogenic in Fisher 344 rats (Levine et al. 1983) or Sparague-Dawley rats (Hart 1977) exposed to RDX in the diet for 2 years. However, Lish et al. (1984) reported a statistically significant increase in the combined incidence of hepatocellular carcinomas and adenomas in female B6C3F1 mice fed RDX in the diet for two years.

EPA (1988) derived a reference dose (RfD) of 0.003 mg/kg/day for RDX based on a chronic study in which male and female Fischer rats received RDX in the diet for 24 months at dosages of 0, 0.3, 1.5, 8.0, or 40 mg/kg bw/day (Levine et al. 1983). Rats in the three highest dose groups experienced statistically significant increases in mortality, anemia with secondary splenic lesions, hepatotoxicity, cataracts, and urogenital lesions. A lowest-observed-adverse-effect level (LOEAL) of 1.5 mg/kg/day was identified based on suppurative

inflammation of the prostate. The no-observed-adverse-effect-level (NOAEL) was 0.3 mg/kg/day.

EPA (1989) has classified RDX in Group C -- possible human carcinogen and has developed an oral potency factor of $0.11 \text{ (mg/kg/day)}^{-1}$. The potency factor was based on the increased incidence of combined hepatocellular carcinomas and adenomas in female mice receiving RDX in the diet for two years at doses of 7, 35 or 100 mg/kg.

Selenium

Selenium was detected in the monitoring well within the production well capture zone, Areas 1, 2, and 7 groundwater wells, in ditch B surface waters, and in Area 9 surface soils.

Results of studies with humans and experimental animals indicate that certain selenium compounds are readily absorbed from the gastrointestinal tract following oral exposure (EPA 1984). The pulmonary absorption of selenium following inhalation exposure has not been well studied, although there are reports suggesting that selenium is absorbed to some extent by this route (EPA 1984). Selenium is an essential element and therefore is nontoxic at doses necessary for normal health and nutrition. NAS (1980) reported that an adequate and safe selenium intake for an adult human ranges from 0.05 mg/day to 0.2 mg/day. However, exposure to selenium at levels that exceed these standards has been associated with adverse health effects. Such effects observed in experimental animals following subchronic or chronic oral exposure to various selenium compounds have included anemia, reduced growth, increased mortality, and lesions of the liver, heart, kidney, and spleen (EPA 1984). In humans, chronic oral exposure to selenium has been associated with alopecia, dermatitis, discoloration of the skin, loss of fingernails, muscular dysfunction, convulsions, paralysis, and increased incidences of dental caries (EPA 1984). Headaches and respiratory irritation have been noted in humans following acute inhalation exposure (EPA 1984). Studies with a variety of

animals have suggested that selenium may be teratogenic; however, these studies are limited in that exposure levels are not well characterized (EPA 1984).

Oral and inhalation reference doses (RfD) of 3.0×10^{-3} mg/kg/day and 1.0×10^{-3} mg/kg/day, respectively, have been derived by EPA (1984, 1988). The oral RfD value was based on a study by Yang et al. (1983) in which humans exposed to selenium in the diet at doses of 3.2 mg/day developed loss of hair, loss of fingernails, dermatitis, and muscular dysfunction. By applying an uncertainty factor of 15 and a LOAEL of 3.2 mg/day, EPA (1984) determined the oral RfD value of 3×10^{-3} mg/kg/day. The oral RfD is currently under review by the oral RfD Work Group at EPA (1988). The inhalation RfD value was based on an occupational study by Glover (1967) in which workers exposed to airborne concentrations of selenium developed dermatitis and gastrointestinal disturbances. An uncertainty factor of 10 was used to determine the inhalation RfD (EPA 1988).

Silver

Silver was detected in all areas except Area 14 and the residential well. It was also detected in surface waters in the Area 16 leachate seep.

Silver in various forms is absorbed to a limited extent following oral and inhalation exposures (EPA 1985). The acute toxic effects in humans following oral exposure to silver include corrosive damage to the GI tract leading to shock, convulsions, and death. In animals, acute exposure has been shown to affect the central nervous system and to cause respiratory paralysis (Hill and Pillsbury 1939). The primary effect of silver in humans following chronic exposures, is argyria, a permanent bluish-metallic discoloration of the skin and mucous membranes, which can be either localized or generalized. Silver also accumulates in the blood vessels and connective tissue (EPA 1985).

EPA (1988) derived an oral reference dose (RfD) of 3.0×10^{-3} mg/kg/day for silver based on the human case reports of Gaul and Staud (1935), Blumberg and Carey (1934), and East et al. (1980). In these studies, argyria was observed at an average dose of silver of 0.0052 mg/kg/day, to which an uncertainty factor of 2 was applied.

Tetrachloroethene

Tetrachloroethene was detected in the monitoring well within the production well capture zone, Area 7, 16, and 17 wells, and the residential well. It was also seen in surface water in the Area 16 leachate seep. Tetryl was detected in the monitoring well capture zone and Area 12 and 17 groundwater wells.

Tetryl

Tetryl was detected in the monitoring well within the production well capture zone and Area 12 and 17 groundwater wells.

Information on the toxicity of tetryl is sparse. It has been shown to be mutagenic in DNA repair assays (McGregor et al. 1980). In occupational situations it has been shown to be a skin sensitizer following air exposures and a TLV of 1.5 mg/m³ has been recommended for tetryl (ACGIH 1988). An oral reference dose can be derived from the TLVs by assuming complete absorption of a chemical by both inhalation and ingestion, an inhalation volume of 10 m³ per eight-hour work day, and a 5 day work week. In addition, a safety factor of 100 is applied to the TLV to account for sensitive members of the population and for the use of an exposure level that is higher than a no-effect level in deriving the RfD. (See Layton et al. 1986 for a more complete discussion of this methodology.) Using this approach, an RfD of 0.0015 mg/kg/day is derived.

Toluene

Toluene was detected in Area 17 groundwater wells and the residential well and in surface water in the Area 16 leachate seep.

Toluene is absorbed in humans following both inhalation and dermal exposure (EPA 1985). In humans, the primary acute effects of toluene vapor are central nervous system (CNS) depression and narcosis. These effects occur at concentrations of 200 ppm (754 mg/m³) (von Oettingen et al. 1942a,b). In experimental animals, acute oral and inhalation exposures to toluene can result in central nervous system (CNS) depression and lesions of the lungs, liver, and kidneys (EPA 1987). The earliest observable sign of acute oral toxicity in animals is depression of the CNS, which becomes evident at approximately 2,000 mg/kg (Kimura et al. 1971). In humans, chronic exposure to toluene vapors at concentrations of approximately 200 and 800 ppm has been associated with CNS and peripheral nervous system effects, hepatomegaly, and hepatic and renal function changes (EPA 1987). Toxic effects following prolonged exposure of experimental animals to toluene are similar to those seen following acute exposure (Hanninen et al. 1976, von Oettingen et al. 1942a). A dose-related reduction in hematocrit values was observed in rats chronically exposed to toluene (CIIT 1980). There is some evidence in mice that oral exposure to greater than 0.3 ml/kg toluene during gestation results in embryotoxicity (Nawrot and Staples 1979). Inhalation exposure of up to 1,000 mg/m³ by pregnant rats during gestation has been associated with significant increases in skeletal retardation (Hudak and Ungvary 1978).

EPA (1988a) has derived an oral risk reference dose (RfD) of 0.3 mg/kg/day for toluene based on a 24-month inhalation study in which rats were exposed to concentrations as high as 300 ppm (29 mg/kg/day) and hematological parameters were examined (CIIT 1980). No adverse effects were observed in any of the treated animals. Using a no-observed-adverse-effect level (NOAEL) of 29 mg/kg/day and an uncertainty factor of 100, the oral RfD was derived. EPA

(1988b) reported an inhalation RfD for toluene of 1.0 mg/kg/day also based on this CIIT study in which CNS effects were noted and an uncertainty factor of 100 was used.

1,1,1-Trichloroethane

1,1,1-Trichloroethane was detected in Area 1, 5, and 17 groundwater wells.

Like other chlorinated aliphatic hydrocarbons, 1,1,1-trichloroethane (1,1,1-TCA, methyl chloroform) is rapidly and completely absorbed following both the oral and inhalation exposure. Pulmonary absorption is initially large and gradually decreases to a steady-state condition. Absorption through the skin is slow. 1,1,1-TCA distributes throughout the body and readily crosses the blood-brain barrier (EPA 1984). The most notable toxic effects of 1,1,1-TCA inhalation exposure in humans and animals are central nervous system depression, including anesthesia at very high concentrations, and impairment of coordination, equilibrium, and judgment at lower concentrations (350 ppm and above). In both humans and animals, cardiovascular effects, including premature ventricular contractions, decreased blood pressure, and sensitization to epinephrine-induced arrhythmia can result from acute exposure to high concentrations of 1,1,1-TCA vapor (EPA 1985). Fatty liver changes have been reported in guinea pigs following subchronic inhalation exposure (Torkelson et al. 1958). NTP (1984) reported preliminary results of bioassays in rats and mice indicating that oral administration of 1,1,1-TCA increases the incidence of hepatocellular carcinomas in female mice but not for male rats. This study was inadequate to evaluate the carcinogenicity of 1,1,1-TCA in female rats and male mice.

EPA (1988a) calculated an oral reference dose (RfD) for 1,1,1-trichloroethane based on an inhalation study by Torkelson et al. (1958) in which rats, rabbits, guinea pigs and monkeys were exposed to 1,1,1-TCA vapor. A no-observed-adverse-effect (NOAEL) of 500 ppm (2,730 mg/m³, or 90 mg/kg/day) was identified from this study. Using the NOAEL of 90 mg/kg/day and an

uncertainty factor of 1,000, a RfD of 9×10^{-2} mg/kg/day was derived. An inhalation RfD of 0.3 mg/kg/day for 1,1,1-TCA also has been determined by EPA (1988b) based on this same study, in which hepatotoxicity was observed in guinea pigs. An uncertainty factor of 1,000 was used in calculating the RfD.

1,1,2-Trichloroethane

1,1,2-Trichloroethane was detected in Area 16 and 17 groundwater wells.

1,1,2-Trichloroethane (1,1,2-TCA) is rapidly absorbed from oral, inhalation and dermal exposures (Torkelson and Rowe 1981, Arena 1979). In humans, acute oral and inhalation exposures to 1,1,2-TCA result in central nervous system (CNS) depression, equilibrium disturbances, vertigo, headaches, lassitude, hypotension, anesthesia and coma (Arena 1979). Acute oral and inhalation administration to animals produces liver and kidney damage, irritation to the eyes and nose, CNS depression, and death due to respiratory arrest (ACGIH 1986, Torkelson and Rowe 1981). In dogs the hepatotoxic effects include hepatocyte vacuolation, enzyme induction, fatty degeneration and necrosis (NRC 1977, Torkelson and Rowe 1981). The hepatotoxicity and nephrotoxicity of 1,1,2-TCA has been found to be potentiated by pretreatment with certain halogenated organic compounds and solvents. Dermal exposures result in irritation and injury to the skin from defatation (Torkelson and Rowe 1981). Evidence suggests that 1,1,2-TCA is embryo toxic to chicken eggs (Elovaara 1979). 1,1,2-TCA was found to be weakly mutagenic in *S. Cerevisiae* (Torkelson and Rowe 1981). Oral administration of 1,1,2-TCA has been associated with the induction of hepatocellular carcinomas and pheochromocytomas in mice but not in rats (NCI 1978, Weisburger 1977).

EPA has classified 1,1,2-TCA in group C (Possible Human Carcinogen). This category applies to agents for which there is limited evidence of carcinogenicity in animals. EPA (1988) has derived a cancer potency factor of 5.7×10^{-2} (mg/kg/day)⁻¹ for both oral and inhalation exposures based on an increased incidence of liver tumors in mice (NCI 1978). EPA (1988) has also

established an oral reference dose (RfD) of 4.0×10^{-3} mg/kg/day for 1,1,2-TCA based upon clinical chemistry alterations in mice given 3.9 mg/kg/day in drinking water. (White et al 1985, Sanders et al 1985). An uncertainty factor of 1.000 was used to calculate the RfD.

Trichloroethene

Trichloroethene was detected in groundwater in the production wells, the monitoring well within the production well capture zone and Area 5, 8, 16, and 17 wells. It was also detected in surface water in the Area 16 leachate seep and the big ditch.

Absorption of trichloroethene (TCE) from the gastrointestinal tract is virtually complete. Absorption following inhalation exposure is proportional to concentration and duration of exposure (EPA 1985). TCE is a central nervous system depressant following acute and chronic exposures. In humans, single oral doses of 15 to 25 ml (21 to 35 grams) of TCE have resulted in vomiting and abdominal pain, followed by transient unconsciousness (Stephens 1945). High-level exposure can result in death due to respiratory and cardiac failure (EPA 1985). Hepatotoxicity has been reported in human and animal studies following acute exposure to TCE (EPA 1985). Nephrotoxicity has been observed in animals following acute exposure to TCE vapors (ACGIH 1986, Torkelson and Rowe 1981). Subacute inhalation exposures of mice have resulted in transient trichloroethene-induced increased liver weights (Kjellstrand et al. 1983). Industrial use of TCE is often associated with adverse dermatological effects including reddening and skin burns on contact with the liquid form, and dermatitis resulting from vapors. These effects are usually the result of contact with concentrated solvent, however, and no effects have been reported after exposure to TCE in dilute, aqueous solutions (EPA 1985). Trichloroethene has caused significant increases in the incidence of hepatocellular carcinomas in mice (NCI 1976) and renal tubular-cell neoplasms in rats exposed by gavage (NTP 1983), and pulmonary adenocarcinomas in mice following inhalation exposure (Fukuda et al. 1983). Trichloroethene was

mutagenic in *Salmonella typhimurium* and in *E. coli* (strain K-12), utilizing liver microsomes for activation (Greim et al. 1977).

EPA (1988) classified trichloroethene in Group B2--Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animals studies. EPA (1988) derived an oral cancer potency factor of 1.1×10^{-2} (mg/kg/day)⁻¹ and an inhalation cancer potency factor of 4.6×10^{-3} (mg/kg/day)⁻¹ based on the mouse liver tumor data in the NCI (1976) and NTP (1983) gavage studies. EPA (1987) developed an oral reference dose (RfD) of 7.35×10^{-3} mg/kg/day based on a subchronic inhalation study in rats in which elevated liver weights were observed following exposure to 55 ppm, 5 days/week for 14 weeks (Kimmerle and Eben 1973). A safety factor of 1,000 was used to calculate the RfD. However, this RfD is currently under review by EPA.

1,3,5-TNB

1,3,5-TNB was detected in the monitoring well within the production well capture zone, Area 4, 7, 9, 12, and 17 groundwater wells and in surface water in the Area 13 drainage ditch and the Area 16 leachate seep.

Information on the toxicity of 1,3,5-trinitrobenzene is sparse. It has been shown to be mutagenic in DNA repair assays (McGregor et al. 1980). Acute oral toxicity also has been demonstrated with LD₅₀ values of 572 mg/kg, 450 mg/kg, and 730 mg/kg being reported for mice, rats and guinea pigs, respectively (EPA 1987). Quantitative information on nonlethal effects in humans and animals is lacking. However, exposure in humans has been associated with methemoglobinemia, cyanosis, headache, nausea and other effects. An oral RfD of 0.0025 mg/kg/day is derived by applying a conversion factor of 5×10^{-6} to the oral RfD of 450 mg/kg, as recommended by Layton et al. (1986).

Vinyl chloride

Vinyl chloride was detected in groundwater in the production wells, the monitoring wells within the production well capture zone, and Area 5 and 16 wells.

Vinyl chloride is rapidly absorbed in rats following oral and inhalation exposure, while dermal absorption of vinyl chloride is minor (EPA 1985). At high inhalation exposure levels, workers have experienced dizziness, headaches, euphoria, and narcosis. In experimental animals, inhalation exposure to high levels of vinyl chloride can induce narcosis and death. Lower doses result in ataxia, narcosis, congestion and edema of the lungs, and hyperemia in the liver (EPA 1985). Chronic inhalation exposure of workers to vinyl chloride is associated with hepatotoxicity, central nervous system disturbances, pulmonary insufficiency, cardiovascular toxicity, gastrointestinal toxicity, and acro-osteolysis (EPA 1985). Experimental animals chronically exposed via inhalation or ingestion have exhibited effects involving the liver, spleen, kidneys, hematopoietic system, and skeletal system (EPA 1984). Feron et al. (1975) found that administration of vinyl chloride to rats by gavage resulted in hematologic, biochemical, and organ-weight effects at doses above 30 mg/kg/day. Evidence for an association between human exposure to vinyl chloride and birth defects or fetal loss is conflicting (EPA 1987). Human exposure to vinyl chloride has been associated with an increased incidence of hepatic angiosarcoma and brain, lung, and hemolymphopoietic cancers. In animal studies, chronic inhalation and ingestion of vinyl chloride at levels as low as 1.7 and 5 mg/kg/day have induced cancer in the liver and in other tissues of rats and mice (IARC 1979; Feron et al. 1981; Maltoni et al. 1980, 1981).

EPA (1988) has classified vinyl chloride in Group A (Human Carcinogen) based on adequate evidence of carcinogenicity from epidemiological studies.

EPA (1988) reported an oral cancer potency factor (q_1^*) of $2.3 \text{ (mg/kg/day)}^{-1}$ for vinyl chloride based on the long-term ingestion study in rats in which lung tumors were observed (Feron et al. 1981). The inhalation cancer potency factor for vinyl chloride is $2.95 \times 10^{-1} \text{ (mg/kg/day)}^{-1}$ (EPA 1988) and is based on a chronic inhalation studies conducted by Maltoni et al. (1980, 1981) in which liver tumors were observed in rats.

Zinc

Zinc was detected in groundwater in all areas except Area 3, in surface water in Area 16 leachate seep and drainage ditch, ditch A, ditch B, and the big ditch, in sediments in Area 13 drainage ditch and ditch B, in Area 9 surface soils, and in Area 8 and 9 subsurface soils.

Zinc is absorbed in humans following oral exposure; however, insufficient data are available to evaluate absorption following inhalation exposure (EPA 1984). Zinc is an essential trace element that is necessary for normal health and metabolism and therefore is nontoxic in trace quantities (Hammond and Beliles 1980). However exposure to zinc at concentrations that exceed recommended levels has been associated with a variety of adverse effects. Chronic and subchronic inhalation exposure of humans to zinc has been associated with gastrointestinal disturbances, dermatitis, and metal fume fever, a condition characterized by fever, chills, coughing, dyspnea, and muscle pain (EPA 1984). Chronic oral exposure of humans to zinc may cause anemia and altered hematological parameters. Reduced body weights have been observed in studies in which rats were administered zinc in the diet. There is no evidence that zinc is teratogenic or carcinogenic (EPA 1984).

EPA (1988) has derived an oral reference dose (RfD) of 2×10^{-1} mg/kg/day based on studies in which anemia and reduced blood copper were observed in humans exposed to oral zinc doses of 2.14 mg/kg/day (Pories et al. 1967, Prasad et al. 1975). A safety factor of 10 was used in developing the RfD.

APPENDIX I

LIST OF COMMON AND SCIENTIFIC NAMES OF
WILDLIFE SPECIES AT LCAAP

APPENDIX I

LIST OF COMMON AND SCIENTIFIC NAMES OF WILDLIFE SPECIES AT LCAAP

Common Name	Scientific Name
<u>Birds</u>	
Canada goose	<u>Branta canadensis</u>
wood duck	<u>Aix sponsa</u>
bobwhite quail	<u>Colinus virginianus</u>
wild turkey	<u>Meleagris gallopavo silvestris</u>
woodcock	<u>Philohela minor</u>
mourning dove	<u>Zenaidura macroura</u>
Cooper's hawk	<u>Accipiter cooperii</u>
red-shouldered hawk	<u>Buteo lineatus</u>
red-tailed hawk	<u>Buteo jamaicensis</u>
sharp-shinned hawk	<u>Accipiter striatus</u>
kestrel	<u>Falco sparverius</u>
barn owl	<u>Tyto alba</u>
screech owl	<u>Otus asio</u>
great horned owl	<u>Bubo virginianus</u>
common flicker	<u>Colaptes auratus</u>
downy woodpecker	<u>Dendrocopos pubescens</u>
red-bellied woodpecker	<u>Centurus carolinus</u>
red-headed woodpecker	<u>Melanerpes erythrocephalus</u>
common raven	<u>Corvus corax</u>
common crow	<u>Corvus brachyrhynchos</u>
fish crow	<u>Corvus ossifragus</u>
blue jay	<u>Cyanocitta cristata</u>
loggerhead shrike	<u>Lanius ludovicianus</u>
eastern meadowlark	<u>Sturnella magna</u>
robin	<u>Turdus migratorius</u>
Carolina wren	<u>Thryothorus ludovicianus</u>
American goldfinch	<u>Spinus tristis</u>
horned lark	<u>Eremophila alpestris</u>
tufted titmouse	<u>Parus bicolor</u>
white-breasted nuthatch	<u>Sitta carolinensis</u>

APPENDIX I

LIST OF COMMON AND SCIENTIFIC NAMES OF WILDLIFE SPECIES AT LCAAP (Continued)

Common Name

Scientific Name

Mammals

coyote
white-tailed deer
gray fox
red fox
muskrat
opossum
eastern cottontail rabbit
raccoon
striped skunk
fox squirrels

Canis latrans
Odocoileus virginianus
Urocyon cinereoargenteus
Vulpes fulva
Ondatra zibethicus
Didelphis virginiana
Sylvilagus aquaticus
Procyon lotor
Mephitis mephitis
Sciurus niger

Fish

largemouth bass
bluegill
green sunfish
channel catfish
blue catfish
golden shiner

Micropterus salmoides
Lepomis macrochirus
Lepomis cyanellus
Ictalurus punctatus
Ictalurus furcatus
Notropis crysoleucas